Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

SHOUT
SHARE
IT

84B

UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1287

Washington, D. C. ▼ March, 1925

U. S. F. S. RECEIVED
LIBRARY
APR - 1925

EXPERIMENTS WITH CEREALS AT THE AKRON (COLO.) FIELD STATION IN THE 15-YEAR PERIOD, 1908 TO 1922, INCLUSIVE

By

FRANKLIN A. COFFMAN

Associate Agronomist, Office of Cereal Investigations
Bureau of Plant Industry

CONTENTS

	Page
The Cereal Experiments	1
Description of the Field Station	2
Experimental Methods	18
Experiments with Wheat	21
Experiments with Oats	40
Experiments with Barley	44
Experiments with Minor Crops	48
Experiments with Corn	52
Comparison of Grain Crops	57
Choice of Crops and Types of Farming Recommended	59
Summary	60

WASHINGTON
GOVERNMENT PRINTING OFFICE
1925

UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1287

Washington, D. C. ▼ March, 1925

EXPERIMENTS WITH CEREALS AT THE AKRON (COLO.) FIELD STATION IN THE 15-YEAR PERIOD, 1908 TO 1922, INCLUSIVE

By FRANKLIN A. COFFMAN, *Associate Agronomist, Office of Cereal Investigations Bureau of Plant Industry*

CONTENTS

	Page
The cereal experiments	1
Description of the field station	2
Location	2
History of the district	3
Soil of the district	4
Native vegetation	6
Climatic conditions	6
Crops of the district	11
Experimental methods	18
Preparation of the soil	18
Plat experiments	18
Nursery experiments	20
Experiments with wheat	21
Winter wheat	21
Spring wheat	31
Comparison of spring and winter wheats	38
Experiments with oats	40
Experiments with barley	44
Experiments with minor crops	48
Winter rye	48
Spring rye	49
Winter emmer	49
Spring emmer	50
Spelt	50
Proso	50
Flax	50
Buckwheat	51
Grain sorghum	51
Experiments with corn	52
Comparison of grain crops	57
Choice of crops and types of farming recommended	59
Summary	60

THE CEREAL EXPERIMENTS [1]

The investigations with cereals conducted at the Akron Field Station during the past 15 years have consisted chiefly of varietal studies, experiments on rate, date, and method of seeding, and the improvement of cereals by selection. The objects for which these investigations have been conducted are: (1) To determine the best crops, crop varieties, and strains for the region; (2) to improve cereal varieties by breeding; and (3) to determine the best methods of cereal production.

[1] The Akron Field Station is operated by the Office of Dry-Land Agriculture Investigations of the Bureau of Plant Industry. The cereal experiments are conducted by the Office of Cereal Investigations in cooperation with that office. These experiments were begun in 1907. Wilson G. Shelley was in charge from March 1, 1908, until February 28, 1911. Clyde McKee was then appointed scientific assistant and placed in charge of cereal investigations at Akron, which position he retained till February 15, 1913. He was then succeeded by Charles H. Clark, who remained until July 1, 1913, on which date he was transferred to take charge of the flax investigations of the Office of Cereal Investigations. George A. McMurdo was placed in charge of the cereal experiments at the time of Mr. Clark's transfer, which position he retained until February, 1917, when he resigned. He was succeeded by the writer in July, 1917.

5421—25——1

The experiments reported in this bulletin have been conducted wholly on dry land. The results obtained from the experiments to and including 1915 have been published,[2] as have certain results obtained since that time.[3] This bulletin was prepared in order to make available the unpublished results from the experiments conducted since 1915.

In many cases the data obtained since 1915 show considerable variance from those obtained before that year. Seasonal conditions have varied widely, with resulting great fluctuations in the yields of the different cereals. As this bulletin contains the results obtained over a period of 15 years, the data herein presented should indicate the relative values of the different cereals and should show definitely which are the best varieties and the best cropping systems for this region. The results obtained at the Akron Field Station are applicable to a large part of eastern Colorado and adjacent portions of northwestern Kansas, western Nebraska, and southeastern Wyoming, especially on what are locally termed "hard lands." The irrigated river valleys and the sand-hill sections present somewhat different conditions.

The yields of the cereals compare very favorably with those obtained under dry-land conditions in other parts of the United States. Winter wheat, corn, barley, spring wheat, and oats are the most important cereals in this section. Wheat and corn are each of greater economic importance than all other cereals combined.

DESCRIPTION OF THE FIELD STATION

LOCATION

The Akron Field Station is located in northeastern Colorado, about 60 miles from the Nebraska line on the east as well as on the north, where Nebraska extends west beyond the northeast corner of Colorado to Wyoming. The station is 4 miles east of Akron, the county seat of Washington County. The town of Akron is located about 112 miles east of Denver, Colo., on the main line of the Chicago, Burlington & Quincy Railroad, running from Chicago and St. Louis to Denver. The railroad bounds the field station on the south. The station is slightly west and north of 40° N. latitude and 103° W. longitude. The altitude is about 4,560 feet.

The station contains about 227 acres. Of this area 160 acres, known as the "forestry quarter," are owned by the Colorado Agricultural Experiment Station. The remaining 67 acres, lying directly south of the "forestry quarter," are controlled by the United States Department of Agriculture. General views of the buildings of the station in 1908 and in 1923 are shown in Figures 1 and 2. These clearly indicate the growth of the experiment station in the past 15 years.

---

[2] McMurdo, George A. Cereal experiments at the Akron Field Station, Akron, Colo. U. S. Dept. Agr. Bul. 402, 35 p., 11 fig. 1916.

[3] Warburton, C. W., and T. R. Stanton. Experiments with Kherson and Sixty-Day oats. U. S. Dept. Agr. Bul. 823, p. 47–48. 1920.

Clark, J. Allen, John H. Martin, and Ralph W. Smith, Varietal experiments with spring wheat on the northern Great Plains. U. S. Dept. Agr. Bul. 878, p. 30–32. 1920.

Zook, L. L. Winter wheat in western Nebraska. Nebr. Agr. Exp. Sta. Bul. 179, p. 36, 37. 1922.

HISTORY OF THE DISTRICT

The district in which the station is located forms part of what was once called the Great American Desert. It was the feeding ground for the bison and antelope and the home of the prairie dog, coyote, jack rabbit, and badger. The bison has long since been exterminated, and but few antelope remain. The jack rabbits, prairie dogs, coyotes, and badgers are still numerous. This was the hunting ground of the western Indian tribes, and traces of Indian life are yet to be found in many places.

The first white men to inhabit this district were the cattlemen, who held vast areas under their control. Following the building of the railway through the section in 1883, homesteading was begun. The prospect of free land brought thousands of settlers who knew nothing of dry-land farming practices and conditions.

Among the settlers arriving in 1885 was M. F. Vance, a farmer who still lives near the station and one of the men who was instrumental

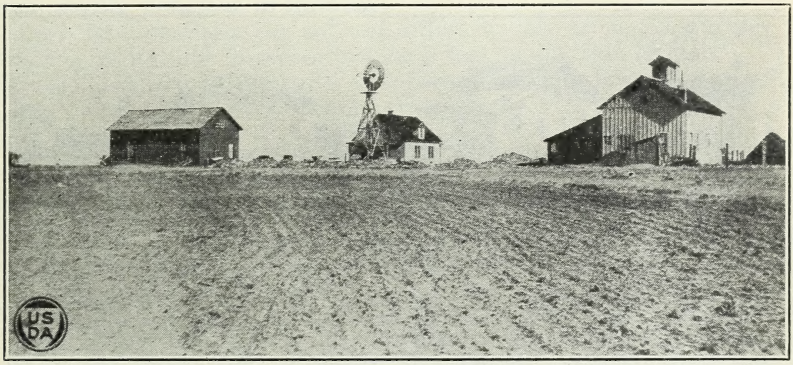

FIG. 1.—View of the buildings at the Akron Field Station in 1908

in getting it located at Akron. He states that homesteading was active as early as 1885, and that the peak of this early settlement was reached about 1886 or 1887. The cattlemen practically abandoned the section to the farmers about 1887. By that year also the towns established by the first settlers had grown almost to their present size, and some were considerably larger than now. Periods of severe drought occurred in the late eighties and again in 1893 and 1894. A bad grasshopper outbreak occurred in 1895, and the two following years also were unfavorable to crop production. During this period of bad years people left in large numbers, many of them not remaining even long enough to obtain patents to their land. Many who remained were forced to mortgage their land, only to lose it later by foreclosure. The great reduction of the farming population reacted immediately on the towns, and they also were largely deserted. Some buildings in the towns were loaded on cars and shipped away, and many others were moved out to the country by the ranchers who stayed.

A second period of severe drought occurred about 1901, and it was not until 1905 or 1906 that the district became permanently settled. Rural telephone systems and rural free delivery of mail were established generally between 1910 and 1912. The so-called Campbell system of dry farming was established during this period; but it failed to control the soil blowing, which was disastrous at times. A demonstration farm operated on this system was located only 2 miles east of the station. The increase in population and development of the section was gradual up to about 1915. At about that time the boom in wheat prices due to the World War caused a period of extremely rapid development, which reached its peak early in 1920. The deflation begun in 1921 again caused many farmers to leave this portion of the country, and much land is now owned by nonresidents.

Farm experience and scientific experiments are building up a stable system of agriculture. During the past 10 years hundreds of thousands of acres of new land have been broken and are being cropped, largely by resident landowners. The expansion and improvement

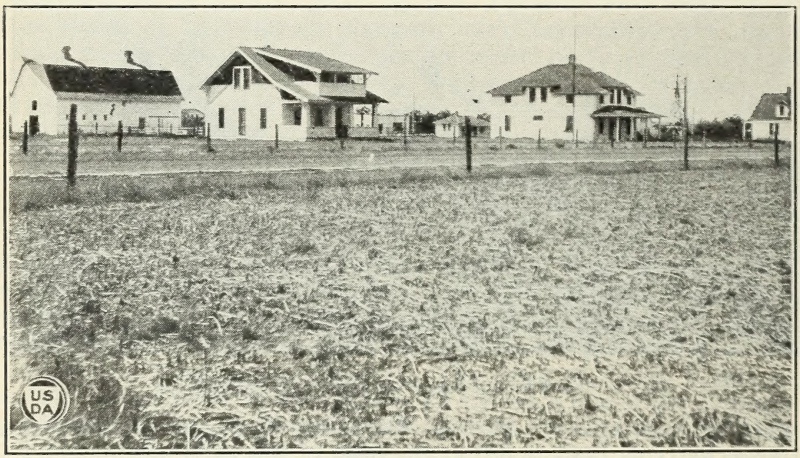

FIG. 2.—View of the Akron Field Station in 1923

of diversified agriculture during the past 15 years have been remarkable, as has been the use of better machinery and equipment, with which the farmers of the section are able to cultivate large acreages more efficiently and with a greater profit than before.

By the general use of the automobile and the telephone and the spread of the rural mail-delivery system, distances have been largely overcome. Although many farmers are located many miles from trading points, the comparative isolation of a few years ago no longer exists. The towns of the district have had an unusual growth in population and volume of business. The deflation since the World War has caused many financial disasters, but the future prospect for this section is promising.

SOIL OF THE DISTRICT [4]

The observations presented are believed to be generally applicable throughout the district, which includes northeastern Colorado and small adjacent portions of southeastern Wyoming, southwestern

[4] Description adapted from U. S. Dept. Agr. Bul. 402.

Nebraska, and northwestern Kansas. This district is a rolling prairie, which roughly outlined lies between the thirty-eighth and forty-third parallels of latitude and between the one hundred and first and one hundred and fifth meridians. In elevation, it lies between the 3,500 and 5,500 foot contours. The only important river traversing the district is the Platte, the waters of which during the summer months are often reduced to the proportions of a creek. The water supply is almost entirely from wells, which vary in depth from a few to several hundred feet. In some localities water has not been found at any depth.

Geologically, the district in which the station is located was once a part of the bed of a Cretaceous sea. The soil contains numerous deposits of various fossils which add to the natural fertility. The rolling character of the surface is partially due to the action of wind. Although vegetation retards such action, soil movements due to wind are still in progress, especially in the more sandy sections. Depressions formed by wind often have no drainage outlet. The result of combined natural forces has produced a sandy soil, often of considerable depth, deficient in humus.

In a few localities the subsoil differs widely from the surface soil. Clay is sometimes found only 1 or 2 feet below the surface. To the experienced eye the natural vegetation is an indicator of the character of the soil.[5] Any examination of the soil of this region is incomplete until a few holes have been dug to a depth of several feet.

An estimate based on the figures of the census of 1920 places the proportion of cultivated land in the section in which the Akron Field Station is located at between 25 and 50 per cent of the total area, and the proportion in cereals at about 60 per cent of the cultivated area. The percentage of cultivated land can be further increased; but the possible extension of cultivation in some sections is limited, as the very sandy lands should not be broken on account of soil blowing.

The soil of the station and of the adjacent territory is classed as sandy loam. To the north and west of this section the soil is of a lighter and more sandy type. Various local names are used to distinguish the soil types, those most commonly used being "hard land" for soil such as is found at the Akron Field Station and "soft land" for that of the more sandy type. The surface of the field station ranges from nearly level to slightly rolling. There are no protecting hills. However, the forestry shelter belt on the west, north, and east sides of the station has afforded some slight protection for adjacent land during the past few winters.

Considerable variation exists in the soil used for experimental purposes, but by the replication of plats and the use of check plats the effects of these variations have been overcome to some extent. At the Akron Field Station the dark surface soil usually varies from 1 to 2 feet in depth, below which the soil is of a light color, owing to lack of organic matter. Little coarse gravel is present in the soil of the experimental areas, and there is no impervious layer near enough to the surface to affect root development or water movements. Plowing and other tillage operations are easily performed when the soil is moist but become very difficult when the moisture content is low. Spring winds are a factor to be considered, as the fine soil particles are readily blown by the wind when the soil is dry.

---

[5] Shantz, H. L. Natural vegetation as an indicator of the capabilities of land for crop production in the Great Plains area. U. S. Dept. Agr., Bur. Plant Indus. Bul. 201, 100 p., 23 fig., 6 pl. 1911.

NATIVE VEGETATION [6]

The native vegetation of the locality consists largely of the grama–buffalo-grass association. The principal grasses are blue grama (*Bouteloua gracilis* Lag.; *B. oligostachya* Torr.), buffalo grass (*Bulbilis dactyloides* (Nutt.) Raf.), and western wheatgrass (*Agropyron smithii* Rydb.; *A. occidentale* Scribn.). Needle grass (*Stipa comata* Trin. and Rupr.) and wire grass (*Aristida longiseta* Steud.) are frequently found. In the more sandy sections bunch grass (*Andropogon scoparius* Michx.), sand grass (*Calamovilfa longifolia* (Hook.) Scribn.), big bluestem (*Andropogon hallii* Hack.), and black grama (*Bouteloua hirsuta* Lag.) often occur. Other grasses found in the district are June grass (*Koeleria cristata* (L.) Pers.) and little barley grass (*Hordeum nodosum* L.). Grama grass and buffalo grass are more commonly observed on the higher unbroken soils of the "hard lands." Western wheatgrass occupies the lower slopes and bottoms, and needle grass and wire grass are more often observed on edges of old roadways or trails. In the more sandy sections, or "soft lands," the native vegetation consists mostly of bluestem, bunch grass, black grama, and sand grass. On soils of either type the "niggerwool," bull sod, or blackroot (*Carex filifolia* Nutt.) is found to some extent and causes considerable trouble in sod breaking.

The more common weeds are sunflower (*Helianthus petiolaris* Nutt.), gumweed or rosinweed (*Grindelia squarrosa* (Pursh) Dunal), peppergrass (*Lepidium* sp.), yucca or soapweed (*Yucca glauca* Nutt.), wild alfalfa (*Psoralea tenuiflora* Pursh), white mountain lily (*Leucocrinum montanum* Nutt.), and wild garlic (*Allium* sp.). Sand sage (*Artemisia filifolia* Torr.) is common in the sandy soils. Two species of the locoweed (*Astragalus* spp.) are found in the region, and a few species of cactus are commonly observed.

CLIMATIC CONDITIONS

PRECIPITATION

The precipitation at Akron is similar to that of most of the central Great Plains, especially eastern Colorado, western Kansas, and western Nebraska. The precipitation decreases to the west, toward the foothills of the Rocky Mountains, where there is a rapid increase. The rainfall is also greater on the high divide between the Platte and Arkansas Rivers than at lower elevations to the north and south. In the river valleys the additional precipitation from local summer showers, which follow the valleys, considerably affects the total. The average annual precipitation in this section varies between 15 and 20 inches. Local storms of greater or less importance occur every year. Most of the summer precipitation is of a local nature. The limits of these local storms may be clearly marked, an inch or more of rainfall occurring at a distance of only a few miles from a point where no precipitation is received. Torrential summer showers are not unknown, and often much damage results from hail.

The distribution of precipitation throughout the year is often not favorable to cereal production. The annual and average precipitation by months at Akron from 1908 to 1922 is shown in Table 1.

[6] See Shantz, H. L. Op. cit.

TABLE 1.—*Monthly, seasonal, and annual precipitation at the Akron Field Station during the 15-year period, 1908–1922, inclusive*

[Data in inches. T=trace]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Seasonal, Apr. to Sept.	Annual
1908	------	0.34	T	1.70	3.30	2.37	2.42	1.47	0.05	3.20	2.00	T	11.31	16.85
1909	T	1.38	3.06	.40	1.87	3.32	4.61	3.77	2.16	.86	.48	.55	16.13	22.46
1910	0.05	.16	.26	3.96	2.06	1.38	1.47	3.72	3.81	.05	.12	.32	16.40	17.36
1911	.60	.44	.06	2.63	1.15	1.48	1.34	1.30	2.40	1.47	.28	1.36	10.30	14.51
1912	.28	1.43	.78	2.49	2.86	3.39	3.58	1.58	1.88	1.99	.18	.29	15.78	20.73
1913	.22	.40	1.57	2.19	1.44	1.35	1.85	1.14	2.08	.34	.70	3.27	10.05	16.55
1914	.03	.32	.20	4.01	1.46	3.54	1.66	1.05	.23	2.08	.10	.90	11.95	15.58
1915	1.10	1.68	1.50	5.19	4.13	3.75	1.10	3.51	1.76	.48	.15	.65	19.44	25.00
1916	.50	T	.09	1.59	2.24	2.09	1.77	2.82	.26	1.02	.75	.61	10.77	13.74
1917	.28	.63	.72	.96	7.79	.56	1.52	1.78	2.19	.57	T	.50	14.80	17.50
1918	.70	.80	.60	1.20	1.76	.96	3.10	7.36	2.43	1.07	.75	1.55	16.81	22.28
1919	.07	.50	.65	1.96	1.59	2.27	1.79	.44	2.62	1.64	1.29	.70	10.67	15.52
1920	T	.02	.90	3.28	2.90	3.97	4.72	1.45	1.80	.44	.47	.90	18.12	20.85
1921	1.22	T	1.25	2.77	.47	1.32	2.88	.92	.79	.97	.20	.65	9.15	13.44
1922	.65	.25	.15	3.96	3.62	1.43	3.24	1.24	.06	.05	1.90	.10	13.55	16.65
Average	.38	.56	.79	2.55	2.58	2.21	2.47	2.24	1.63	1.08	.62	.82	13.68	17.93

Since records have been kept the total annual precipitation at Akron has varied from 13.44 inches in 1921 to 25 inches in 1915. The average annual precipitation during the 15 years from 1908 to 1922, inclusive, was 17.93 inches. This is believed to be slightly above

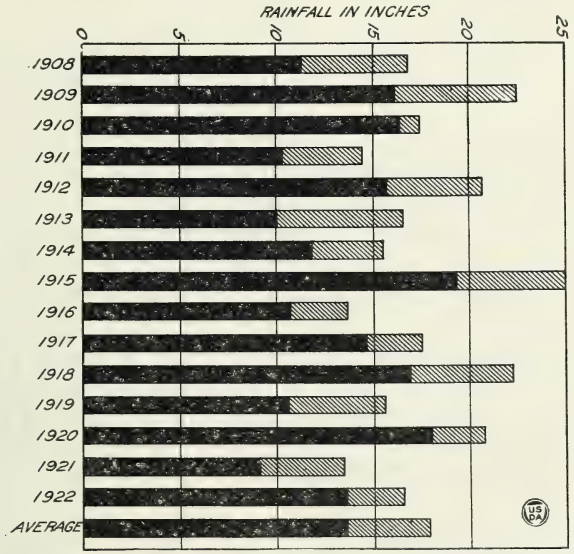

FIG. 3.—Annual (black and crosshatched combined) and seasonal (black), April to September, inclusive precipitation at the Akron Field Station during the 15-year period, 1908–1922, inclusive

the normal for the section around Akron. In 10 years the precipitation was less than the 15-year average and in 5 years it exceeded the average, so that the average is possibly slightly more than may normally be expected. Of the total annual precipitation an average of 13.68 inches was received during the months of April, May, June, July, and August, or during the period which most affects cereal production. The seasonal precipitation is a prominent factor affecting the yields

of grain. Figure 3 shows graphically the annual and seasonal precipitation at Akron for the 15 years from 1908 to 1922, inclusive.

The limiting factor in crop production at Akron is nearly always the moisture supply, although winter grains have been injured by low temperatures and hail sometimes causes severe crop losses. The yields of spring grains, however, are determined largely by the amount and distribution of the seasonal precipitation. In some seasons, as that of 1918, the rains came too late to benefit the cereals. In several other seasons the lack of moisture during the heading and ripening period caused low yields.

Rains of less than one-fourth inch during the growing season unless followed or preceded by other rains within 24 hours are of almost no value to grain crops in this section. In 1921 but 9.15 inches of precipitation were recorded during the growing season. There was practically no rainfall heavy enough to be of value to crops from April 15 until after the crops were harvested in July.

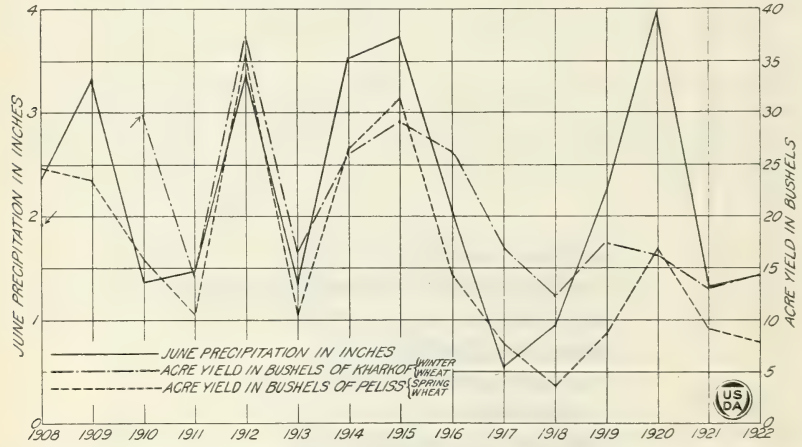

FIG. 4.—Graphs showing June precipitation and acre yields of Kharkof and Peliss wheats at the Akron Field Station during the 15-year period, 1908–1922, inclusive

Figure 4 shows graphically the relation of the June precipitation to the yields of Kharkof winter wheat (C. I. No. 1583) and Peliss durum spring wheat (C. I. No. 1584). Table 2 gives these data in tabular form. In 1909 no winter wheat was grown, and in 1920 the stand of winter wheat was poor, owing to soil blowing and winterkilling. In the fall of 1918 no winter-wheat varieties were sown in plats, and the yield given for 1919 in Table 2 is the average of two increase plats of Kharkof, one sown on cornland and one on fallow. The diagram (fig. 4) shows that a marked relation exists between June precipitation and crop yields. In nearly every case a heavy June precipitation is followed by a good yield of wheat, whereas a low precipitation in June has resulted in a lowering of the wheat yield.

EVAPORATION

The seasonal evaporation at Akron is closely related to the seasonal precipitation, and among the factors which influence crop growth it possibly ranks second. The daily evaporation has been recorded at the station during the growing months since the station was estab-

lished, and the total evaporation in inches by months from April to September, inclusive, is shown in Table 3. The evaporation is determined from a free water surface, the method being that employed at all of the stations where the Biophysical Laboratory of the Bureau of Plant Industry has cooperated.[7]

TABLE 2.—*June and seasonal precipitation and yields of Kharkof winter*[1] *and Peliss durum spring wheats grown at the Akron Field Station during the 15-year period, 1908–1922, inclusive*

Year	Precipitation (inches)		Acre yield (bushels)	
	June	April to July, inclusive	Kharkof wheat	Peliss wheat
1908	2.37	9.79	19.3	24.7
1909	3.32	10.20	(2)	23.6
1910	1.38	8.87	29.8	15.8
1911	1.48	6.60	14.2	10.6
1912	3.39	12.32	37.5	35.6
1913	1.35	6.83	16.6	10.5
1914	3.54	10.67	26.0	26.6
1915	3.75	14.17	29.2	31.6
1916	2.09	7.69	26.2	14.4
1917	.56	10.83	16.9	7.8
1918	.96	7.02	12.3	3.7
1919	2.27	7.61	[3] 17.6	8.8
1920	3.97	14.87	16.1	16.9
1921	1.32	7.44	13.0	9.1
1922	1.43	12.25	14.2	7.9
Average	2.21	9.81	19.3	16.5

[1] Wheat previous to 1917 usually was sown on fallow; yields for 1917 and succeeding years are averages of plats grown on fallow and on cornland.
[2] No winter wheat survived the winter of 1908–09.
[3] Winter wheat was not sown in the varietal plats in the fall of 1918, and the yield given for 1919 is the average of two increase plats of Kharkof.

The average evaporation for the six months from April to September, inclusive, during the 15 years from 1908 to 1922, was 43.048 inches. The lowest total evaporation, 33.55 inches, was recorded in 1915, the year of greatest rainfall during the same months. The highest total evaporation, 48.818 inches, was recorded in 1911. The precipitation from April to September was lower than that of 1911 in only two years. Thus, the evaporation usually varies inversely with the precipitation, though this is not always the case.

The ratio of precipitation to seasonal evaporation, also given in Table 3, shows the evaporation for the 15 years to be more than three times the precipitation. In 1915 and 1920 the ratio was narrowest, and in 1911, 1916, 1919, and 1921 it was widest. The ratio of precipitation to evaporation is a fair indication of the seasonal moisture conditions as related to crop yields.

WIND

Records of wind velocity have been kept at the Akron Field Station since 1908. The average monthly velocities vary to a considerable extent, but the annual velocity is usually between 6 and 7 miles per hour.

As a rule the atmosphere during January and February is quiet except during the snowstorms, which often become blizzards. During March, April, and May the most severe windstorms and the highest

[7] Briggs, L. J., and J. O. Belz. Dry farming in relation to rainfall and evaporation. U. S. Dept. Agr., Bur. Plant Indus. Bul. 188, p. 16-20. 1910.

average wind velocities of the year usually occur. These often do much damage by soil blowing. The highest monthly average wind velocity recorded at the station was 10.4 miles per hour in April, 1919. June and July are generally months of comparative quiet in atmospheric movement, and August usually shows less wind movement than any other month of the year, the velocity averaging little more than 5 miles per hour. Hot winds are almost unknown in this section. September and October are usually very variable as to atmospheric conditions, winds sometimes occurring of sufficient velocity to start considerable soil movement. There are comparatively few periods of high wind velocity in November and December, but those which occur generally accompany snowstorms and may result in severe blizzards.

TABLE 3.—*Monthly evaporation from a free water surface at the Akron Field Station from April to September of each year from 1908 to 1922, inclusive*

[Evaporation and precipitation data in inches]

Year	Evaporation							Precipitation, Apr. to Sept.	Ratio of precipitation to evaporation
	Apr.	May	June	July	Aug.	Sept.	Seasonal, Apr. to Sept.		
1908	4.740	7.709	7.637	8.474	7.826	8.550	44.936	11.31	1:3.97
1909	4.734	6.825	7.003	9.396	8.538	5.857	42.353	16.13	1:2.63
1910	6.387	5.797	8.722	9.763	7.142	5.810	43.621	16.40	1:2.66
1911	5.841	7.323	9.753	9.774	8.944	7.183	48.818	10.30	1:4.74
1912	4.535	7.097	6.750	7.618	7.048	4.648	37.696	15.78	1:2.39
1913	4.330	5.840	8.180	9.260	9.310	6.040	42.960	10.05	1:4.27
1914	4.290	5.608	7.509	8.654	8.364	7.438	41.863	11.95	1:3.50
1915	4.220	5.033	5.883	6.660	5.961	5.793	33.550	19.44	1:1.73
1916	6.208	7.811	7.979	11.116	7.216	6.836	47.166	10.77	1:4.38
1917	4.081	4.930	8.424	10.186	8.464	6.624	42.709	14.80	1:2.89
1918	4.102	6.780	9.329	9.252	7.676	4.283	41.422	16.81	1:2.46
1919	4.951	7.381	8.756	10.282	9.718	6.144	47.232	10.67	1:4.43
1920	4.786	6.840	6.961	8.582	6.918	6.825	40.912	18.12	1:2.26
1921	5.505	6.245	7.773	10.708	8.594	7.078	45.903	9.15	1:5.02
1922	4.276	6.792	8.225	9.200	8.853	7.233	44.579	13.55	1:3.29
Average	4.866	6.534	7.926	9.262	8.038	6.423	43.048	13.68	1:3.14

TEMPERATURE

The temperatures at the station are recorded daily throughout the year by means of maximum and minimum thermometers, supplemented by a thermograph. The nights at Akron are cool during the entire year. The winter temperatures, although low, are not so low nor are the summer temperatures so high as in most parts of the northern Great Plains. The cool summer temperatures are due to the high elevation. The absolute minimum during the period is −28° F., recorded December 8, 1919, and the absolute maximum is 103° F., recorded July 30, 1913. The temperature has not been a limiting factor in the yields of most of the cereals. The grain sorghums were frosted several times before they were fully mature, but the development of earlier maturing strains possibly will eliminate this danger. During some years winter wheat was injured by low temperatures, but injury by cold is unusual unless the low temperatures are accompanied by other factors, such as low moisture supply or high wind velocity.

The dates of the last killing frost in the spring and the first in the autumn for each year are shown in Table 4. Unless otherwise stated, a temperature of 32° F. is recorded as frost, although on

many occasions no specific record exists of frost having occurred with that temperature. The latest spring frost was recorded on June 4, 1919, and the earliest autumn frost was observed September 13, 1914. The average frost-free period was 140 days, but this has varied from 121 days in 1916 to 165 days in 1918. The frost-free period is long enough to permit full maturity of all adapted cereal varieties at the station.

TABLE 4.—*Dates of the last killing frost in spring and the first in autumn at the Akron Field Station for each year, 1908–1922, inclusive*

Year	Killing frosts (32° F.)		Frost-free period (days)	Year	Killing frosts (32° F.)		Frost-free period (days)
	Last in spring	First in fall			Last in spring	First in fall	
1908	May 7	Sept. 25	141	1917	May 11	Oct. 8	150
1909	May 16	Oct. 3[1]	140	1918	...do...	Oct. 23	165
1910	May 16[2]	Sept. 25	132	1919	June 4	Oct. 4	122
1911	May 10	Oct. 7[1]	150	1920	May 15	Sept. 29	137
1912	May 13	Sept. 20	130	1921	May 7	Oct. 1	147
1913	May 3	Sept. 19	139	1922	Apr. 28	Oct. 7	162
1914	May 12	Sept. 13	124				
1915	May 20	Oct. 4	137	Average	May 13	Sept. 30	140
1916	May 16	Sept. 14	121				

[1] First frost occurred after this date, when record ended.
[2] Temperature of 32° F. recorded June 9, but probably no frost.

CROPS OF THE DISTRICT

The station represents in a general way that portion of the western United States lying between 101° and 105° longitude and 38° and 43° latitude. This district is high in altitude, ranging from about 3,500 to 5,500 feet. The rainfall is low, varying with the locality and season from about 10 to 25 inches. As most of the precipitation falls during the growing season and the frost-free period is between four and five months in length, the district is well adapted to the production of grain crops. Although some land is farmed by irrigation, possibly over 90 per cent of the entire cropped area is dry farmed. Figure 5 shows the general outline of the district.

Winter wheat is the most important grain crop, perhaps equaling in importance all others combined. Nearly 3,000,000 acres of winter wheat were grown in this district in 1921. The increase in acreage of hard red winter wheat has been remarkable. With the continued rapid increase in the acreage brought under cultivation, the area devoted to winter wheat in this district may continue to increase at the present rate of several hundred thousand acres annually for the next several years. Winter wheat yields well, generally averaging from 12 to 15 bushels, so that the annual production of the district probably is close to 40,000,000 bushels at present. Figure 6 shows the distribution of the winter-wheat acreage.

Next to winter wheat, corn is the most important crop. The production of corn in this district is for the most part to the east and north of the station. The total area in corn was between 1,500,000 and 1,750,000 acres in 1921. Corn is by far the most popular of the feed-grain crops now grown. This is possibly because most of the farmers are from the Corn Belt and also because the crop fits well into a rotation with winter wheat. The corn varieties grown

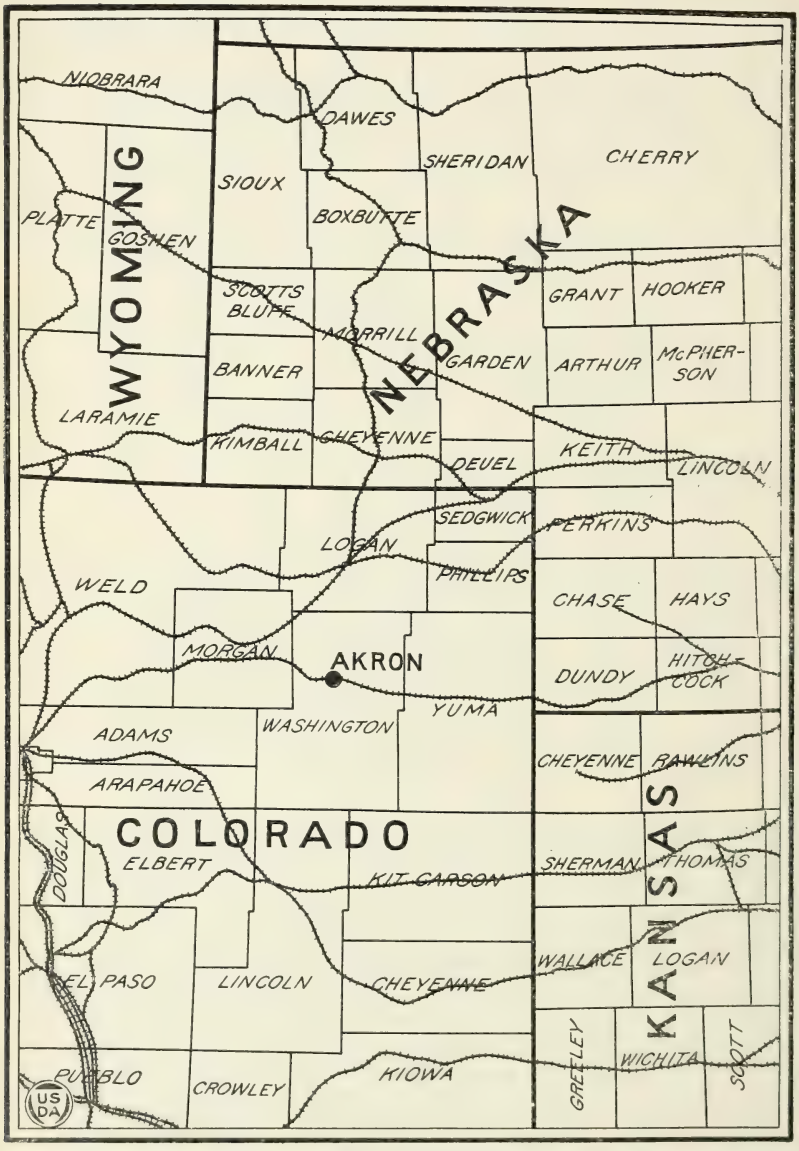

FIG. 5.—Map showing the district to which the data in this bulletin are believed to be applicable, with location of the Akron Field Station

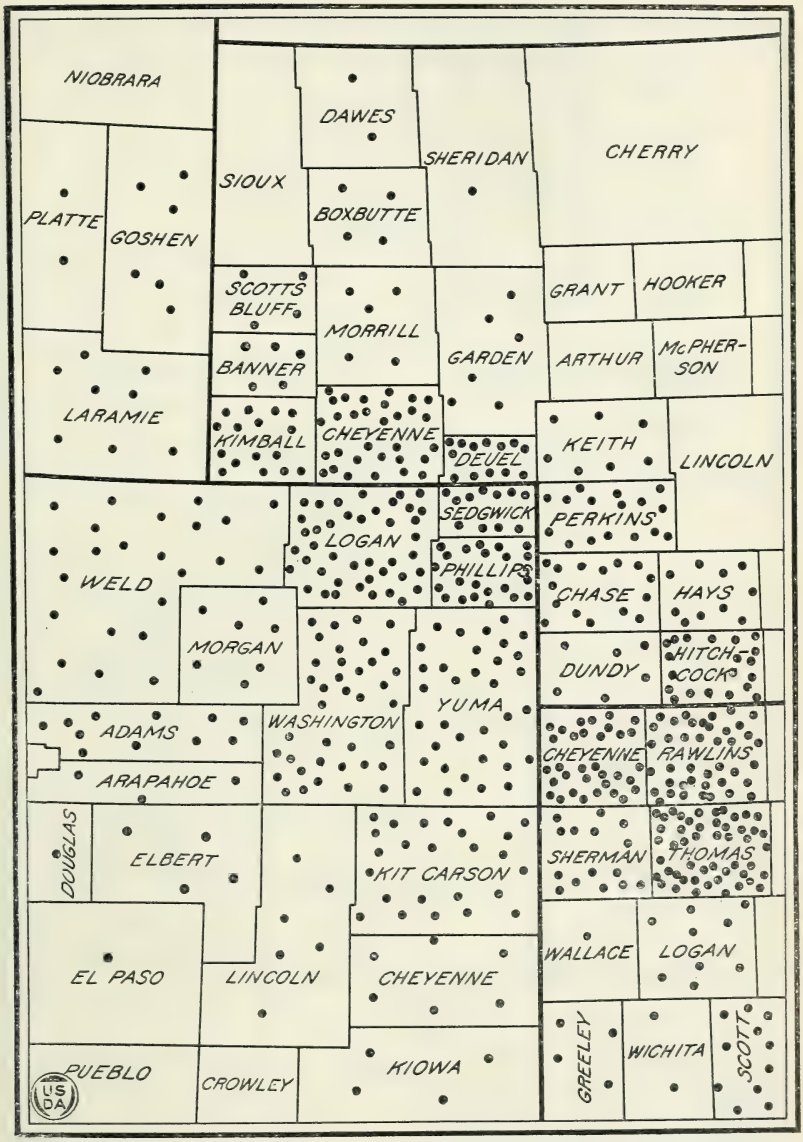

FIG. 6.—Map showing the distribution of winter-wheat acreage in the Akron district in 1921. Each dot represents 5,000 acres

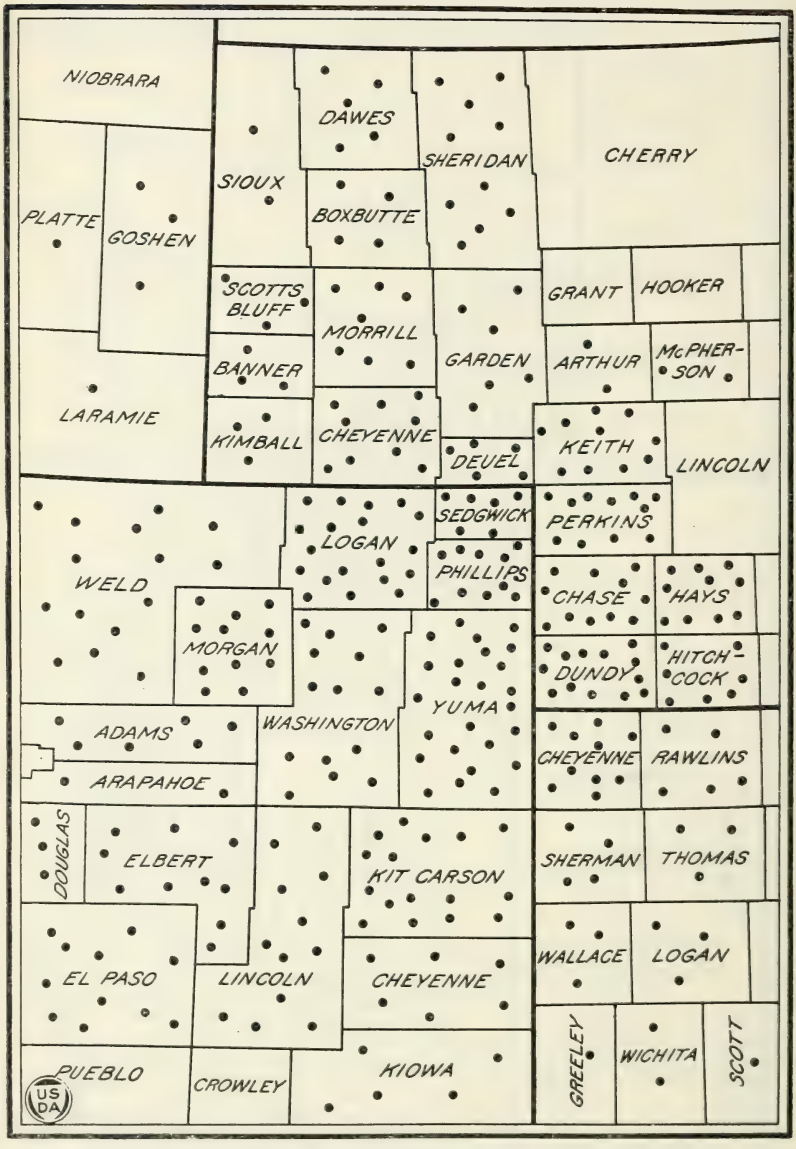

FIG. 7.—Map showing the distribution of corn acreage in the Akron district in 1921. Each dot represents 5,000 acres

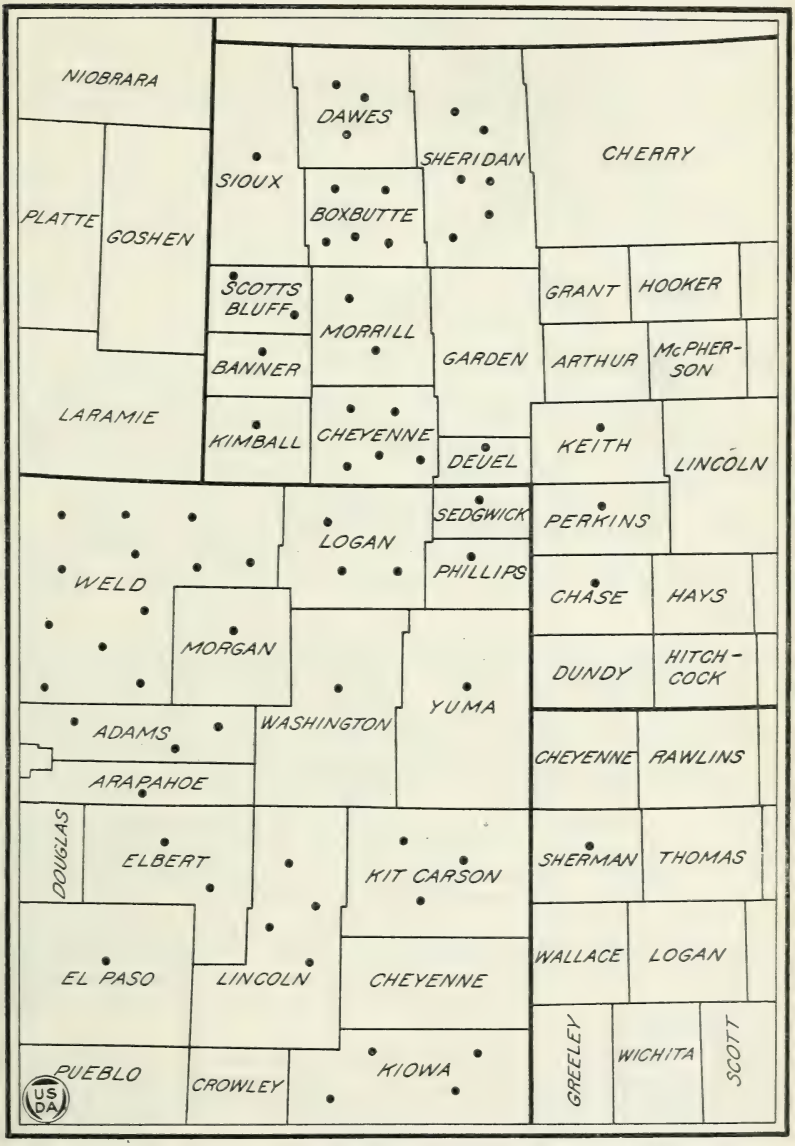

FIG. 8.—Map showing the distribution of spring-wheat acreage in the Akron district in 1921. Each dot represents 5,000 acres

in this district are local strains, many of which are of inferior quality. There is an excellent field for corn improvement. Although the production of corn is not so certain as it is farther east, average acre yields of 15 to 25 bushels are usual, and yields of 40 to 60 bushels are sometimes obtained. The average corn production of the district is possibly about 30,000,000 bushels. Figure 7 shows the distribution of the corn crop in 1921.

Spring wheat is a crop of secondary importance, although the district was considered to be a factor in spring-wheat production 10 years ago. At present much of the spring wheat is grown on irrigated land, especially in Colorado. On dry land Turkey winter wheat is much superior to the spring varieties. About 350,000 acres of spring wheat are now grown annually. As much of this acreage is irrigated, the average yields are usually from 15 to 20 bushels to the acre. Possibly 6,000,000 bushels of spring wheat are grown annually. Figure 8 shows the distribution of the spring-wheat acreage. The durum varieties are most popular on the dry land, but hard red spring wheat usually is grown under irrigation.

Barley is rapidly growing in popularity. As a feed crop it ranks next to corn in acreage and in the average year possibly equals it in acre yield of grain in pounds. It is the most important of the spring small grains sown on dry-farmed land, but is not extensively grown under irrigation. About 350,000 acres of barley are grown in this district. Figure 9 shows the distribution of the barley acreage. The growing of barley centers near the northwest corner of Kansas. The average acre yield of barley is from 15 to 25 bushels, and the annual barley crop of the district is estimated at 7,000,000 to 8,000,000 bushels.

The other important cereal crops grown in this district are oats, winter rye, and grain sorghums. Small acreages of proso, flax, and winter emmer are also sown. Oats are more extensively grown in the irrigated valleys and in the extreme northern part of the district on the dry lands. Possibly 300,000 acres of oats are grown annually. The average yields of oats on the irrigated lands are high, and the annual crop is probably close to 8,000,000 bushels.

Winter rye is an especially valuable crop in the more sandy sections because of its ability to withstand soil blowing. It has recently become a popular crop for seeding on the "hard lands" for pasture. At present it is the most popular sown pasture crop. Winter rye does not equal hard red winter wheat for grain production in this district, as it yields less and the market price is lower. Possibly 200,000 acres of winter rye are sown for grain each season. The average acre yield is around 10 to 15 bushels and the total annual production close to 2,500,000 bushels.

The growing of grain sorghum is confined mostly to the southern and eastern portions of the district. Large acreages of sorgo, or saccharine sorghum, are grown for forage, especially in the northern portion, but the later maturity of most of the grain sorghums limits their use. Breeding studies are now under way at Akron with the object of producing grain sorghums suited to the short, cool, growing season of the district; and encouraging results are being obtained. The total area of grain sorghum is about 200,000 acres and the annual production about 3,000,000 bushels. There has been a steady increase in the acreage devoted to grain sorghums during the past 10 years.

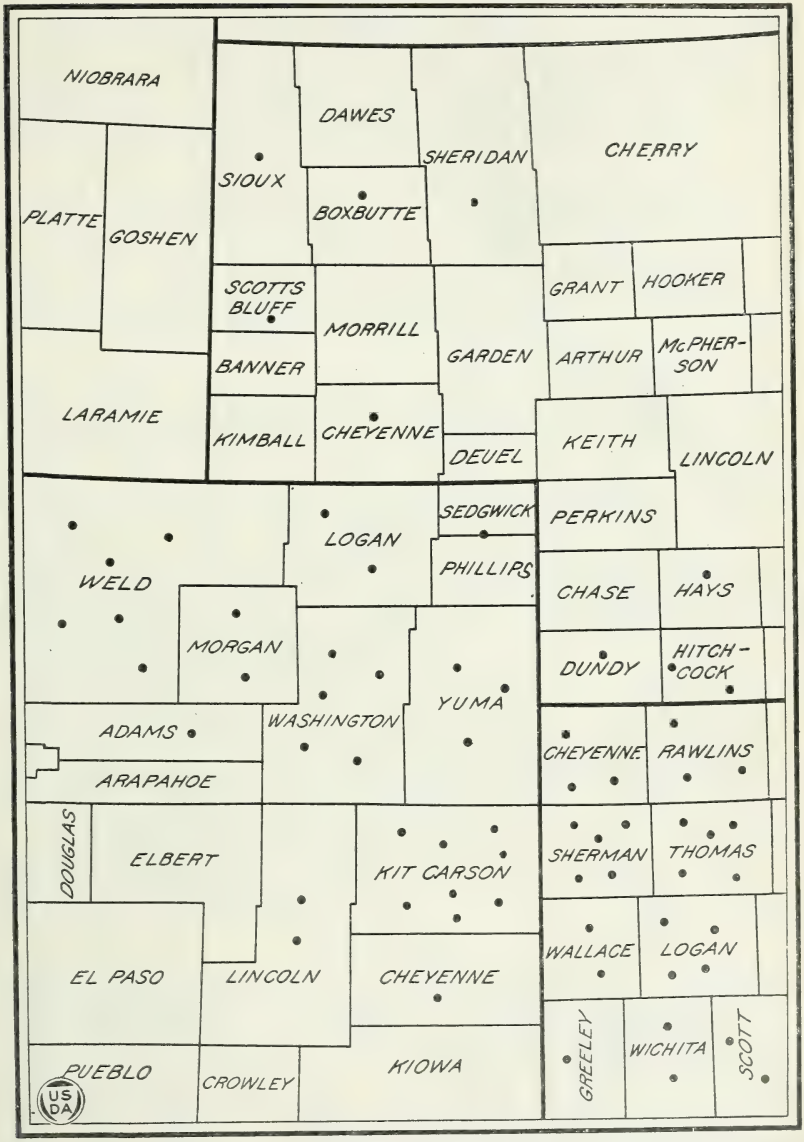

FIG. 9.—Map showing the distribution of barley acreage in the Akron district in 1921. Each dot represents 5,000 acres.

5421—25†——3

EXPERIMENTAL METHODS

PREPARATION OF THE SOIL

Practically all the earlier cereal experiments were conducted on summer fallow. Beginning with the crop of 1917 the varietal, rate-of-seeding, and date-of-seeding experiments with cereals were seeded in quadruplicate, two plats on fallow and two on cornland. Data on each variety, rate, and date thus were obtained on two soil preparations each season. No definite system of fallowing has been followed. The general plan has been to allow the stubble of the previous season's crop to remain undisturbed over winter. In the spring the soil usually was plowed to a depth of 5 to 7 inches, although in a few seasons the plowing was omitted and the soil simply double-disked. During the summer the fallow was kept free from weeds by the use of disk or spring-tooth harrows or a duck-foot cultivator. The usual system followed in preparing the fallow for seeding either fall or spring cereals has been to disk the soil just before seeding time and to smooth the surface with a spike-tooth harrow.

The cornland has presented several problems. The soil preparation has varied slightly; but usually the small-grain stubble of the previous season remains undisturbed until the following spring, when it is double-disked. About the middle of May the corn is listed on the entire area, the rows running across the cereal plats. During the summer the land is cultivated several times to keep down weed growth and prevent the soil from baking. The corn is cut from the plats to be sown to fall grains. On the plats to be sown to spring cereals it is husked and the stalks allowed to stand until early spring, when they are disked into the ground. The chief difference between the two methods is that the standing stalks may catch and hold more snow than the stubble. As a rule, little is left of a stalk field in this section after the winter and early-spring windstorms, and probably disking in the cornstalks does not influence the results obtained.

The nursery experiments always have been conducted on summer fallow, as yields on summer-fallowed land are somewhat higher and more certain than on that prepared by other methods. This is an important consideration where the supply of seed is limited.

No definite cropping system has been followed on land used for conducting experiments with corn, sorghum, buckwheat, flax, proso, and millet, as the experiments with these crops have not been on definitely allotted areas.

PLAT EXPERIMENTS

Practically all experiments except the genetic and breeding studies and the preliminary seedings of varieties and selections were conducted in field plats. Previous to 1917 the field plats were not of standard size. When the station was first established single tenth-acre plats of each variety were grown. With the need for additional plats these tenth-acre plats were subdivided into smaller ones. The tenth-acre plats were 8 rods long by 2 rods wide, separated by alleys 4 or 5 feet in width. The plats now used are 8 rods long and 6 feet wide and are separated by alleys 16 inches in width. These plats contain one fifty-fifth of an acre, but as the plants in them draw considerable moisture and plant food from the alleys it seems fair to consider them as fiftieth-acre plats in computing yields, although the actual area is slightly less.

The experiments with corn, sorghums, and the minor cereals were not grown on plats of standard size. The varietal plats of corn usually consisted of three 8-rod rows and the varietal plats of sorghum of four 8-rod rows. The experiments with proso, flax, buckwheat, and millet usually were sown in fiftieth-acre plats.

Since 1918, promising selections and varieties from the nursery have been sown in hundredth-acre plats on fallow for increase and preliminary plat experiments. Plats of standard varieties of the different cereals are included at regular intervals for checks.

REPLICATION OF PLATS

As the experiments at Akron during the earlier years were conducted very largely on tenth-acre plats, it was not possible to sow more than one plat of each variety. Check plats generally were included at regular intervals in most of the experiments. As the work increased and need for replication became more apparent, reduction in the size of plats was necessary, as the area available was limited. Four plats now are sown of each variety, rate of seeding, and date of seeding included in the regular plat experiments. Check plats have been eliminated, as the sowing of four plats at some distance from each other tends to reduce experimental error due to soil variations. It has not always been possible to include four plats of the less important varieties in the experiments. Two plats were then sown, one on each soil preparation.

No definite plan has been followed in the replication of plats in experiments of corn, sorghum, proso, flax, buckwheat, or millet. Usually one plat of the corn varieties was planted and two of each variety of the other crops. Check plats were included at regular intervals in the corn varietal experiments.

RATES AND DATES OF SEEDING

Fall wheat and rye in the varietal and date-of-seeding experiments have been sown at the rate of 3 pecks to the acre. Spring wheat, rye, emmer, barley, oats, and buckwheat have been sown at the 4-peck rate. Sorghum, flax, millet, and proso usually were sown at the rate of about 20 pounds to the acre, and corn at the rate of about 7 pounds of shelled corn to the acre.

The fall-sown grains generally have been seeded during the month of September. During the past several years the date of seeding has not varied more than a day or two from September 15. The spring grains have been sown as early as practicable. During wet or unfavorable seasons seeding sometimes was considerably delayed. As a rule the seeding of spring grains during the last half of March is advisable, as the weather then is often more favorable than that during April.

Corn usually has been planted as soon as possible after May 15. For the best results in this section it should generally be planted before May 25. Sorghum, proso, buckwheat, millet, and flax were usually seeded about June 1. At that time the danger of frost is not great, and the soil has become sufficiently warm for the seed to germinate.

NURSERY EXPERIMENTS

NATURE AND SCOPE

The nursery experiments conducted at Akron have consisted of seedings of newly introduced varieties, of varieties of which insufficient seed was available for sowing in field plats, and of selections made from valuable commercial strains and from the progeny resulting from crosses. Cultural and other experiments also have been conducted on a limited scale in the nursery.

The testing of selections has been the most important feature of the nursery experiments. The selections have been made (1) to obtain earlier maturing, disease-resistant, and higher yielding strains of wheat, barley, and oats and (2) to obtain awnless and more hardy winter wheats which are equal in yield and quality to the hard red winter wheats now grown.

The nursery experiments have increased greatly during the 15 years since the station was established. In 1908 only 315 nursery rows were sown, and in 1922 more than 4,000 rows of all cereals were grown.

NURSERY METHODS

The nursery methods have varied with the different persons in charge of the experiments, but during the past five years have been similar to those in use on most experiment stations in the United States. A large number of new selections are made from field plats and commercial fields each season. These are carefully described as to plant and kernel characters, and each is sown in a row from 5 to 8 feet in length. When time permits, a definite number of kernels is sown per row, spacing them at regular intervals. Usually, however, these rows are sown with a small drill. The dates of sowing, emergence, heading, and ripening are noted on all seedings, with such other data on hardiness, disease resistance, and yield as appear desirable. Selections which seem to be promising in the head-row experiments are increased to rod rows the following season, and those showing undesirable characters are dropped.

The distance between the so-called rod rows is always 1 foot. The row lengths are actually 18 feet for wheat and rye, 17 feet for oats and emmer, and 22 feet for barley. Just before harvest 1 foot of grain is removed from each end of the row, eliminating to some extent the border effect. This leaves 16 feet of row of wheat and rye, 15 feet of oats and emmer, and 20 feet of barley. The third season, selections which have shown average results or better in previous experiments are sown in triplicated rod rows. Checks of parental or of standard varieties are included at regular intervals in both the single and triplicated rod-row experiments. As a rule, selections are grown in triplicate rod rows for two or three seasons, after which the undesirable ones are dropped and the promising ones sown in hundredth-acre plats. The most promising are later included in the varietal experiments. Selections which appear exceptionally promising are increased more rapidly than others. A considerable number of new introductions and selections made at other stations are included in the nursery experiments each season. These are generally sown in triplicated rod rows and are afterwards increased or discarded. A great many varieties have been tested in this way, but comparatively few have ever shown sufficient promise to warrant seeding them in plats.

Previous to 1920 all grain from nursery rows was threshed by flailing; but a nursery thresher was made that year, which has since been used.

EXPERIMENTS WITH WHEAT

The experiments with wheat at Akron included both winter and spring varieties in plats and nursery rows. Varietal, rate-of-seeding, and date-of-seeding experiments have been conducted, and considerable attention has been given to the production of improved varieties by selection. It had been shown that winter wheat is the crop of prime importance in that part of the Great Plains in which Akron is located. Consequently, the experiments with winter wheat have been much more extensive than those with any other cereal and in most seasons have equaled in number and extent those with all other cereals combined. The experiments with spring wheat have ranked second in importance. A harvesting scene in a winter-wheat field in northeastern Colorado is shown in Figure 10.

WINTER WHEAT

The experiments with winter wheat have included comparisons of varieties and selections and of different rates and dates of seeding.

FIG. 10.—Harvesting wheat with a header in northeastern Colorado

The greater part of the nursery experiments has been with winter wheat. The results of field and nursery experiments show that only the hard red winter wheats of the Turkey or Crimean group are adapted. Most of the winter-wheat varieties included in the plat experiments are of this type. Many different types have been grown in the nursery, but the best results were obtained from varieties or strains of the Crimean group. Heads and kernels of the two most important varieties of wheat in northeastern Colorado, Turkey and Kanred, are shown in Figure 11.

VARIETAL EXPERIMENTS

The winter-wheat varietal experiments were begun in the fall of 1907. The 1909 crop was almost completely winterkilled, and no winter-wheat plats were sown in the fall of 1918. The varietal experiments to 1917 were grown chiefly on fallow. In 1917 and succeeding years the varieties were sown in quadruplicated plats,

FIG. 11.—Spikes, glumes, and kernels of Turkey (A) and Kanred (B) hard red winter wheats. Spike, face view, natural size; glumes from lower, central, and upper portions of spike, natural size; kernels in three positions and in transverse section, magnified 3 diameters

two on fallow and two on cornland, which has resulted in some reduction in average yield. Good yields were obtained in 1910, 1912, 1914, and 1915. Some plats yielded well in 1920, but the average yields for the year were not high. The yields in 1911, 1913, 1917, 1918, and 1921 were reduced by drought, the seasons of 1911 and 1921 being especially dry. The crops of 1915, 1917, 1920, and 1922 were reduced by winterkilling and soil blowing. The yields of 1915 and 1920 would doubtless have been the best in the history of the station had the plats contained normal stands. Half of the plats sown in the fall of 1916 were abandoned in 1917 on account of winterkilling. The yields of all winter-wheat varieties grown in the varietal experiments are presented in Table 5.

TABLE 5.—*Yields of the winter-wheat varieties grown at the Akron Field Station in one or more years of the 15-year period, 1908–1922, inclusive*

Group and variety	C. I. No.[1]	Acre yield (bushels)															Average		
		1908	1909[2]	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919[3]	1920	1921	1922	1908 to 1922	1917 to 1922[4]	1920 to 1922
CRIMEAN																			
Alberta Red	2979	21.0	0						31.3	25.0	9.7	13.1							
Altara	5797													13.4	7.8				
Armavir	1355–2–2											18.0		17.2					
Beloglina	1543		0	23.6					18.4	21.3	9.0	12.2							
Blackhull	6251													11.8	18.0	8.9			12.9
Crimean	1432	19.2	0																
Do	1435	15.3	0																
Do	1436	19.1	0	38.3	17.9	33.1	12.6	28.3	26.6	20.5	7.0	16.4		19.2	16.7	10.6	19.0	14.0	15.5
Do	1437	14.6	0	34.8	13.3	32.5			26.6										
Do	1559		0	36.9	11.5	32.7	17.0	39.6	29.0	21.7	7.1	15.6							
Kanred	5146										17.6	20.0	21.3	30.1	14.3	14.5		19.3	19.6
Kharkof	1442	20.6	0	27.9	10.0	34.3	16.1	26.6	27.5	19.2	12.9	12.8		15.6	15.0	15.2	18.1	14.3	15.3
Do	1583	19.3	0	29.8	14.2	37.5	16.6	26.0	29.2	26.2	16.9	12.3	17.6	16.1	13.0	14.2	19.4	14.5	14.4
Kharkof (6P4)	4207				10.3	33.2	18.5	26.1	28.3	29.0	13.5	12.8		17.9	10.0	13.1		13.5	13.7
Kharkof (Mont. No. 36)	5549													18.7	10.0	14.6			14.4
Kharkof (Hays No. 2)	6686															15.3			
Karmont	6700														11.1	12.9			
Malakof	2908		0	26.7	17.3	35.4			30.5	18.3	9.0	12.2							
Minturki	6155													18.1	7.0	9.1			11.4
Torgova	1539			20.6															
Turkey	1558	15.7	0																
Do	1571	19.8	0	29.5	11.7	43.1	[5]7.3	25.1	28.1	31.7	8.5	18.4		21.7	15.3	12.7	19.5	15.3	16.6
Do	2998								23.3	30.8	6.1	10.3							
Red Winter	6213													10.7					
MISCELLANEOUS																			
Alton (Ghirka Winter)	1438	15.6	0	38.5	15.8	38.3			22.8	21.0	6.6	14.3		14.4	15.4	11.3		12.4	13.7
Buffum No. 17	3330					17.5	6.5	13.8							9.6	7.9			
Nebraska No. 28	5147										8.9	15.8		8.6					

[1] Accession number of the Office of Cereal Investigations.
[2] All varieties of wheat failed to survive the winter of 1908–09.
[3] Winter wheat was not sown in plats in the fall of 1918. The yields of Kanred and Kharkof reported are from increase fields.
[4] Not including 1919.
[5] Yield of a selection from Turkey (C. I. No. 1571); original variety not grown.

Most of the varieties grown belong to the Crimean group of hard red winter wheats. The exceptions are Alton (Ghirka Winter), an awnless hard red winter variety; Buffum No. 17, an awnless soft red winter wheat; and Nebraska No. 28, an awned soft red winter variety. Some differences in yields have been obtained from the several lots of Crimean wheats grown in all years, but these differences are of doubtful significance. The average yields of the four strains grown each year, Crimean (C. I. No. 1436), Kharkof (C. I. Nos. 1442 and 1583), and Turkey (C. I. No. 1571), show an extreme variation of only 1.4 bushels, which is within the limits of the probable error. These data are shown graphically in Figure 12.

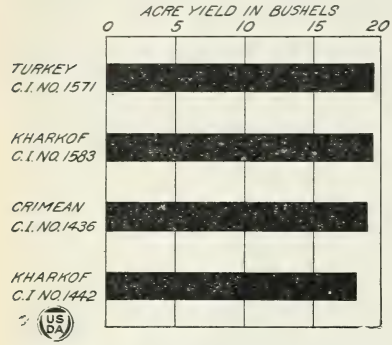

FIG. 12.—Average acre yields of four varieties of hard red winter wheat grown at the Akron Field Station during the 15-year period, 1908–1922, inclusive, except 1919

Annual and average yields of the leading varieties grown on fallow and on cornland from 1917 to 1922, inclusive, are shown in Table 6.

Table 7 shows the average dates of heading and maturity, weight per bushel, yield of grain and straw, and percentages of stem-rust infection recorded on the two strains of Kharkof and one each of Turkey and Crimean wheat from 1908 to 1922, inclusive. In Table 8 similar data are presented on the varieties grown on fallow and on cornland from 1917 to 1922, inclusive.

TABLE 6.—*Yields of the leading varieties of winter wheat grown on fallow and on cornland at the Akron Field Station, 1917–1922, inclusive*

Group and variety	C. I. No.	Acre yield (bushels)[1]													
		Fallow							Cornland						
							Average							Average	
		1917	1918	1920	1921	1922	1917 to 1922[1]	1920 to 1922	1917	1918	1920	1921	1922	1917 to 1922[1]	1920 to 1922
Crimean:															
Kanred	5146	14.8	22.6	27.9	18.6	19.5	20.7	22.0	20.4	17.5	[2]32.3	9.9	9.6	17.9	17.3
Turkey	1571	7.7	20.1	24.5	23.9	17.2	18.7	21.9	9.4	16.8	18.9	6.6	8.3	12.0	11.3
Kharkof	1583	15.6	12.8	19.1	20.8	20.0	17.7	20.0	18.1	11.8	13.2	5.2	8.5	11.4	9.0
Do	1442	12.9	12.7	18.8	24.6	18.7	17.5	20.7	12.9	13.0	12.5	5.4	11.8	11.1	9.9
Crimean	1436	7.0	18.0	19.6	26.2	14.1	17.0	20.0	7.0	14.8	18.8	7.1	7.2	11.0	11.0
Kharkof	4207	13.8	13.2	23.1	16.0	18.3	16.9	19.1	13.3	12.5	12.7	4.0	7.9	10.1	8.2
Do	5549	----	----	23.4	16.3	18.0	-------	19.2	----	----	14.0	3.6	11.3	-------	9.6
Blackhull	6251	----	----	12.2	24.1	9.7	-------	15.3	----	----	11.5	11.9	8.1	-------	10.5
Minturki	6155	----	----	20.4	10.5	10.4	-------	13.8	----	----	15.8	3.5	7.9	-------	9.1
Miscellaneous:															
Alton (Ghirka Winter)	1438	6.5	15.2	17.1	22.5	16.1	15.5	18.6	6.7	13.3	11.7	8.2	6.6	9.3	8.8

[1] No varietal plats of winter wheat were grown at Akron in 1919.
[2] Plats located in favorable position to receive run-off.

TABLE 7.—*Average agronomic data on four varieties or strains of winter wheat grown at the Akron Field Station, 1908–1922, inclusive*

Variety	C. I. No.	Dates of—		Height	Stem-rust infection	Bushel weight	Acre yield	
		Heading	Maturity				Grain	Straw
				Inches	*Per cent*	*Pounds*	*Bushels*	*Pounds*
Crimean	1436	June 18	July 16	32	2—	58.0	19.0	2,213
Kharkof	1442	June 19	July 17	32	2—	58.3	18.1	2,117
Do	1583	---do---	July 16	32	2—	58.4	19.4	2,342
Turkey	1571	June 18	---do---	33	2—	58.1	19.5	2,365

From the data shown in Tables 5 to 8 it is apparent that the unselected varieties, Turkey, Kharkof (C. I. Nos. 1442 and 1583), and Crimean are probably identical in all characters. During the years in which it has been grown the Kanred variety (C. I. No. 5146) has exceeded all other winter wheats in average acre yield by 3 bushels. Figure 13 shows a view of an increase field of Kanred wheat in shock on the Akron Field Station in 1919. The Kharkof selection 6P4 (C. I. No. 4207) is no better than the unselected Kharkof, and as it matures slightly later it does not escape drought so well. The Kharkof selection, Montana No. 36 (C. I. No. 5549), has been grown three years, and the results obtained do not indicate that it is better than the unselected strains.

TABLE 8.—*Average agronomic data recorded on seven varieties and strains of winter wheat grown on fallow and on cornland at the Akron Field Station, 1917–1922, inclusive*

Group and variety	C. I. No.	Dates of—		Height	Stem-rust infection	Bushel weight	Acre yield	
		Heading	Maturity				Grain	Straw
ON FALLOW								
Crimean:				*Inches*	*Per cent*	*Pounds*	*Bushels*	*Pounds*
Kanred	5146	June 21	July 18	32	1.5	57.0	20.7	2,979
Turkey	1571	---do---	July 19	32	5.5	57.6	18.7	2,493
Kharkof	1583	June 22	July 21	33	6.0	58.1	17.7	2,366
Do	1442	June 24	---do---	33	5.0	57.9	17.5	2,171
Crimean	1436	June 22	July 22	31	5.8	56.8	17.0	2,526
Kharkof	4207	---do---	July 21	32	6.5	57.8	16.9	2,214
Average							18.1	2,458
Miscellaneous:								
Alton (Ghirka Winter)	1438	June 23	July 20	34	5.5	56.5	15.5	1,886
ON CORNLAND								
Crimean:								
Kanred	5146	June 19	July 19	31	1.0	57.4	17.9	1,916
Turkey	1571	June 18	July 20	27	3.0	58.4	12.5	1,421
Kharkof	1583	June 20	July 22	27	3.0	58.2	11.4	1,485
Do	1442	June 18	---do---	26	2.3	58.3	11.1	1,415
Crimean	1436	June 19	July 19	27	3.0	57.9	11.0	1,362
Kharkof	4207	June 18	July 22	26	2.3	58.4	10.1	1,339
Average							12.3	1,490
Miscellaneous:								
Alton (Ghirka Winter)	1438	June 19	July 21	29	3.0	58.0	9.3	1,060

Blackhull can not be recommended for the section in which the station is located. The variety has failed to withstand the winters at Akron as well as the other hard red winter wheats. The hardy

varieties Buffum and Minturki have not competed successfully with the earlier maturing varieties of better milling quality. Alton (Ghirka Winter) has yielded little more than the poorest yielding awned varieties and has nothing to recommend it except that it is awnless.

DATE-OF-SEEDING EXPERIMENTS

Date-of-seeding experiments with hard red winter wheat varieties were conducted each year from 1911 to 1918. No winter wheat plats were sown in the fall of 1918, and in the fall of 1919 the combined rate-and-date experiment was started. The date-of-seeding experiments did not follow a definite outline until the fall of 1919, and as a result it is difficult to summarize the data for presentation. Drought reduced the yields of 1911, 1913, 1917, and 1918, but fair yields were obtained in 1912, 1914, 1915, and 1916.

FIG. 13.—An increase field of Kanred winter wheat grown on fallow at the Akron Field Station in 1919 which yielded about 35 bushels to the acre

The yields obtained in 1911 to 1918, inclusive, are shown in Table 9, and Table 10 shows the average agronomic data during the 8-year period. The figures presented show that the earlier seedings have produced better yields than the later seedings in practically every season. The only exception to this rule was in 1911, when wheat sown during the period from November 5 to December 2 yielded better than wheat sown during October or the latter part of September.

TABLE 9.—*Yields obtained in date-of-seeding experiments with Kharkof winter wheat*[1] *grown at the Akron Field Station, 1911–1918, inclusive*

Date of seeding	Acre yield (bushels)									
	1911	1912	1913	1914	1915	1916	1917	1918	Average	
									1911 to 1918	1911 to 1918 except 1913
Sept. 6 to Sept. 21	16.8	[2] 37.5	-------	[3] 26.0	27.3	25.8	16.9	[4] 18.5	--------	24.1
Sept. 28 to Oct. 11	15.5	32.7	14.3	26.6	34.3	22.2	13.2	17.6	22.1	23.2
Oct. 15 to Oct. 30	16.1	15.5	15.6	11.3	25.8	17.5	6.1	11.9	15.0	14.9
Nov. 5 to Dec. 2	16.6	13.3	[5] 10.6	13.6	26.6	21.6	([6])	[7] 10.8	14.1	14.6

[1] Kharkof (C. I. No. 1583) was grown in all years except 1914, when Kharkof (C. I. No. 1442) was grown
[2] Average of six plats.
[3] Sown September 27.
[4] Average of plats sown September 15 and 22.
[5] Average of plats sown November 1 and 15.
[6] Destroyed by soil blowing and winterkilling.
[7] Yield from one plat on fallow; other yields in 1918 are from plats on both corn ground and fallow.

TABLE 10.—*Average agronomic data on Kharkof winter wheat grown in date-of-seeding experiments at the Akron Field Station, 1911–1918, inclusive*

Date of seeding	Emergence to maturity	Dates of—		Height	Stem-rust infection	Bushel weight [1]	Acre yield	
		Heading	Maturity				Grain	Straw
	Days			*Inches*	*Per cent*	*Pounds*	*Bushels*	*Pounds*
Sept. 6 to Sept. 21 [2]	288	June 21	July 18	35	1—	59.4	24.1	2,903
Sept. 28 to Oct. 11	[3] 270	do	July 19	32	1—	57.9	22.0	2,577
Oct. 15 to Oct. 30	[4] 246	June 27	July 23	31	1—	58.6	15.0	2,239
Nov. 5 to Dec. 2	[5]	June 28	July 28	31	1—	58.5	14.1	[6] 3,179

[1] Bushel weights not recorded for all dates in all years.
[2] Average for seven years, no plats sown early in fall of 1912.
[3] Average for seven years, 1917 omitted.
[4] Average for six years, 1912 and 1916 omitted.
[5] Wheat sown after November 5 emerged unevenly during the winter and early spring.
[6] Large straw yield due to abundance of weeds.

RATE-OF-SEEDING EXPERIMENTS

Experiments to determine the best rate to sow hard red winter wheat have been made since 1911, but as no winter-wheat plats were sown in the fall of 1918 and the combined experiments comparing rates and dates of seeding were started in the fall of 1919, the results from the rate-of-seeding experiment are presented for only the 8-year period from 1911 to 1918, inclusive. Good crops were obtained in 1912, 1914, 1915, and 1916. In 1911, 1913, 1917, and 1918 the yields were low, owing to dry weather during the critical stages of growth.

The rates of seeding ranged from 1 to 6 pecks per acre at 1-peck intervals in all years except 1911 and 1912, when they ranged from 2 to 5 pecks per acre. The yields are shown in Table 11, and in Table 12 the average agronomic data for the different rates for the period from 1913 to 1918, inclusive, are presented.

TABLE 11.—*Yields of hard red winter wheat grown in rate-of-seeding experiments at the Akron Field Station, 1911–1918, inclusive* [1]

Rate of seeding per acre	Acre yield (bushels)									
	1911	1912	1913	1914	1915	1916	1917	1918	Average	
									1911 to 1918	1913 to 1918
1 peck			16.3	12.3	27.3	14.2	12.4	6.0		14.8
2 pecks	9.6	38.0	18.3	18.3	30.4	24.8	10.2	12.6	20.3	19.1
3 pecks	10.4	44.0	15.3	24.0	32.9	23.0	12.0	16.0	22.2	20.5
4 pecks	12.8	39.3	16.3	24.3	32.4	22.5	11.0	17.4	22.0	20.7
5 pecks	13.8	38.3	18.6	27.3	34.1	24.0	9.8	17.6	22.9	21.9
6 pecks			18.6	27.3	34.4	30.6	15.7	15.1		23.6

[1] The following varieties and strains have been used in this experiment: Kharkof (C. I. No. 1583) from 1911 to 1913 and from 1916 to 1918, inclusive; Kharkof (C. I. No. 1442) in 1914; Kharkof (C. I. No. 4207) in 1915; Crimean (C. I. No. 1559) from 1915 to 1918; and Kanred (C. I. No. 5146) in 1918. Where more than one variety was grown in rate-of-seeding experiments in any one year, the yields from equal rates of different varieties have been averaged.

The yields obtained from plats sown at different rates from 2 to 6 pecks per acre showed little variation in many seasons. The yields from the lighter seedings, however, have been the lowest most often. In all years the better yields were from the seedings heavier than 2

pecks to the acre. The eight-year average yields from seedings heavier than 2 pecks per acre were from 1.7 to 2.6 bushels more than those from seedings at 2 pecks or less per acre. The data may not be sufficient to permit drawing definite conclusions, but apparently a seeding rate in excess of 2 pecks per acre is more profitable than a seeding rate of 2 pecks or less. A seeding of 3 pecks per acre probably will provide the most favorable return at the least expenditure for seed.

TABLE 12.—*Average agronomic data on hard red winter wheat varieties* [1] *grown in rate-of-seeding experiments at the Akron Field Station, 1913–1918, inclusive*

Rate of seeding per acre	Emergence to maturity	Dates of—		Height	Stem-rust infection	Bushel weight	Acre yield	
		Heading	Maturity				Grain	Straw
	Days			*Inches*	*Per cent*	*Pounds*	*Bushels*	*Pounds*
1 peck	288	June 20	July 19	31	1—	58.5	14.7	1,777
2 pecks	287	do	July 18	29	1—	58.0	19.1	2,172
3 pecks	287	do	do	29	1—	58.3	20.5	2,038
4 pecks	286	June 19	July 17	29	1—	58.2	20.6	2,137
5 pecks	286	do	do	30	1—	58.1	21.9	2,225
6 pecks	286	do	do	29	1—	58.7	23.6	2,454

[1] Kharkof (C. I. No. 1583) was grown in 1913 and from 1916 to 1918, inclusive; Kharkof (C. I. No. 1442) in 1914; Kharkof (C. I. No. 4207) in 1915; Crimean (C. I. No. 1559) from 1915 to 1918, inclusive; and Kanred (C. I. No. 5146) in 1918. Where more than one variety was grown in any one year in rate-of-seeding experiments, the data for equal seeding rates of the varieties in that year have been averaged. As all rates were not grown in 1911 and 1912, the agronomic data for those years have not been included.

An 11-year average yield, for the years 1911–1922 (excluding 1919), may be calculated, adding the average yields from both fallow and cornland given in Table 13 for the years 1920 to 1922. The only dates of seeding which produced satisfactory yields were those in early September and mid-September. If the results from these two dates are averaged and added to those in Table 11, the 11-year average yields for the seedings at 2, 3, 4, and 5 pecks are 20.4, 22.1, 22.0, and 22.6 bushels, respectively. These data still further emphasize the conclusions, given above, that a seeding of 3 pecks or more is warranted.

EXPERIMENTS TO DETERMINE THE BEST RATE AND DATE OF SEEDING

In order to determine the best rate of seeding on each of several dates combined experiments comparing rates and dates of seeding with Kanred winter wheat were started in the fall of 1919. The seeding rates range by 1-peck intervals from 1 to 5 pecks, inclusive. The dates of seeding are August 16, September 1 and 16, and October 1 and 16, or as near thereto as practicable. Duplicate fiftieth-acre plats are sown on fallow and on corn ground at each rate of seeding on each date.

Table 13 presents the annual and average yields on fallow and cornland obtained in 1920, 1921, and 1922 from the different rates sown on the different dates. Table 14 shows the average date of heading and ripening, height of straw, bushel weight, and yields of grain and straw on fallow, together with the average bushel weight and yield of grain and straw on cornland. In general, the wheat on cornland headed and ripened a day or two later than that on fallow. The straw averaged from 3 to 5 inches shorter. No stem-rust infection occurred on the wheat grown from the first two seedings on

cornland, and only 1 to 2 per cent was observed on that from the later seedings. As shown in Table 14, the bushel weight of the wheat from the earliest seeding on fallow was slightly heavier than that of the wheat from the plats sown on the same date on cornland, whereas from the latest seeding the wheat grown on cornland had the heavier bushel weight. Except from the September 16 seeding, the yields of grain on fallowed land were considerably in excess of the yields on cornland. The yields of straw from the wheat on fallow in all cases greatly exceeded those from the wheat on cornland, in some cases being more than double.

TABLE 13.—*Yields of Kanred winter wheat obtained in combined experiments to determine the best rate and date of seeding on fallow and on cornland at the Akron Field Station, 1920–1922, inclusive*

Dates and rates of seeding	Acre yield (bushels)							
	Fallow				Cornland			
	1920	1921	1922	Average	1920	1921	1922	Average
August 16 to 18:								
1 peck	16.6	22.7	10.0	16.4	7.6	10.1	5.0	7.6
2 pecks	27.9	25.1	13.9	22.3	10.6	10.9	5.8	9.1
3 pecks	36.1	24.8	16.5	25.8	16.4	13.7	9.3	13.1
4 pecks	39.2	27.1	19.6	28.6	19.4	13.8	13.0	15.4
5 pecks	42.2	26.6	23.5	30.8	23.2	14.1	15.2	17.5
Average	32.4	25.3	16.7	24.8	15.4	12.5	9.7	12.5
September 1 to 4:								
1 peck	39.5	10.1	19.1	22.9	24.0	6.9	11.8	14.2
2 pecks	43.9	13.7	19.8	25.8	30.4	8.1	13.1	17.2
3 pecks	40.3	15.2	21.6	25.7	38.6	9.1	13.6	20.4
4 pecks	41.8	17.4	21.4	26.9	40.0	10.0	12.5	20.8
5 pecks	43.8	15.7	23.3	27.6	42.2	8.7	14.1	21.7
Average	41.9	14.4	21.0	25.8	35.0	8.6	13.0	18.9
September 16:								
1 peck	26.3	13.7	18.3	19.4	28.3	12.6	16.9	19.3
2 pecks	28.8	15.6	17.0	20.5	32.9	9.2	16.4	19.5
3 pecks	27.9	16.5	20.4	21.6	32.2	11.9	13.5	19.2
4 pecks	28.5	15.2	19.7	21.1	29.7	13.1	13.0	18.6
5 pecks	23.4	15.6	18.7	19.2	25.7	13.9	14.2	17.9
Average	27.0	15.3	18.8	20.4	29.8	12.1	14.8	18.9
October 1:								
1 peck	3.9	9.7	12.6	8.7	3.5	8.8	8.9	7.1
2 pecks	4.2	11.9	14.7	10.3	2.8	10.2	10.2	7.7
3 pecks	6.7	15.5	16.7	13.0	3.4	11.1	10.0	8.2
4 pecks	8.3	16.5	16.6	13.8	4.0	13.0	9.6	8.9
5 pecks	6.1	17.1	18.0	13.7	4.5	11.0	9.8	8.4
Average	5.8	14.1	15.7	11.9	3.6	10.8	9.7	8.0
October 15 to 17:								
1 peck	5.4	14.0	14.1	11.2	4.8	10.1	5.8	6.9
2 pecks	6.8	16.1	16.3	13.1	7.6	12.2	7.5	9.1
3 pecks	7.8	17.3	17.2	14.1	9.7	12.3	7.6	9.9
4 pecks	12.5	18.5	18.6	16.5	9.8	13.3	9.0	10.7
5 pecks [1]	12.8	17.4	19.4	16.5	12.4	17.8	10.6	13.6
Average	9.1	16.7	17.1	14.3	8.9	13.1	8.1	10.0
Summary, all dates:								
1 peck	18.3	14.0	14.8	15.7	13.6	9.7	9.7	11.0
2 pecks	22.3	16.5	16.3	18.4	16.9	10.1	10.6	12.5
3 pecks	23.8	17.9	18.5	20.0	20.1	11.6	10.8	14.2
4 pecks	26.1	18.9	19.2	21.4	20.6	12.6	11.4	14.9
5 pecks	25.7	18.5	20.6	21.6	21.6	13.1	12.8	15.8

[1] Plats of this rate were sown next to a wide alley, and consequently the yields were increased by the border effect.

TABLE 14.—*Average agronomic data for Kanred winter wheat grown in combined experiments to determine the best rate and date of seeding on summer fallow, with comparison of bushel weight and yield on cornland, at the Akron Field Station, 1920–1922, inclusive*

Date and rate of seeding	Emergence to maturity (days)	Dates of—		Height (inches)	Stem-rust infection (per cent)	Bushel weight (pounds)		Acre yield			
		Heading	Maturity					Grain (bushels)		Straw (pounds)	
						Fallow	Cornland	Fallow	Cornland	Fallow	Cornland
August 16 to 18:											
1 peck	320	June 17	July 14	37	1—	58.5	57.2	16.4	7.6	2,182	965
2 pecks	320	June 16	do	37	1—	58.7	56.5	22.3	9.1	2,577	1,106
3 pecks	320	do	do	36	1—	59.0	58.2	25.8	13.1	2,537	1,308
4 pecks	319	do	do	36	1—	59.7	58.4	28.6	15.4	2,891	1,591
5 pecks	319	do	do	36	1—	59.5	58.7	30.8	17.5	2,916	1,825
Average	320	do	do	36	1—	59.1	57.8	24.8	12.5	2,621	1,359
September 1 to 4:											
1 peck	304	June 16	July 16	39	4+	57.5	57.1	22.9	14.2	2,341	1,758
2 pecks	304	do	do	38	4+	57.5	57.6	25.8	17.2	2,749	2,027
3 pecks	304	do	do	37	4+	58.3	58.1	25.7	20.4	2,614	2,166
4 pecks	303	do	July 15	37	4+	58.6	58.3	26.9	20.8	2,802	2,483
5 pecks	303	do	do	37	4+	58.3	58.5	27.6	21.7	2,971	2,425
Average	304	do	July 16	38	4+	58.0	57.9	25.8	18.9	2,695	2,172
September 16:											
1 peck	295	June 18	July 16	35	1+	57.8	57.9	19.4	19.3	2,135	1,762
2 pecks	295	do	do	35	1+	57.5	57.5	20.5	19.5	2,956	1,758
3 pecks	294	do	July 15	34	1+	57.5	58.1	21.6	19.2	2,621	1,898
4 pecks	294	do	do	33	1+	57.5	58.2	21.1	18.6	2,583	1,773
5 pecks	294	do	do	32	1+	58.0	58.5	19.2	17.9	2,150	1,777
Average	294	do	July 15	34	1+	57.7	58.0	20.4	18.9	2,489	1,793
October 1:											
1 peck	269	June 22	July 21	33	3+	54.7	55.3	8.7	7.1	2,481	[1] 1,706
2 pecks	269	do	do	33	4—	55.3	56.4	10.3	7.7	2,196	1,298
3 pecks	269	do	do	32	4—	56.9	57.0	13.0	8.2	2,348	1,248
4 pecks	268	do	July 20	32	5—	56.5	57.8	13.8	8.9	2,663	1,254
5 pecks	268	June 23	do	32	5—	56.8	57.6	13.7	8.4	2,441	1,137
Average	269	June 22	July 21	32	4+	56.0	56.8	11.9	8.1	2,426	1,329
October 15 to 17:											
1 peck	248	June 23	July 20	33	5+	56.0	56.8	11.2	6.9	2,404	1,206
2 pecks	248	do	do	33	5	55.6	57.5	13.1	9.1	2,329	1,252
3 pecks	248	do	do	33	5+	56.6	57.7	14.1	9.9	2,473	1,393
4 pecks	248	do	do	33	5+	56.5	57.5	16.5	10.7	2,781	1,312
5 pecks	248	do	do	33	5+	56.8	57.6	16.5	13.6	2,818	1,554
Average	248	do	do	33	5+	56.3	57.4	14.3	10.0	2,561	1,343
Summary, all dates:											
1 peck	287	June 19	July 17	35	3	56.9	56.9	15.7	11.0	2,309	1,479
2 pecks	287	do	do	35	3	56.9	57.2	18.4	12.5	2,561	1,488
3 pecks	287	do	do	34	3	57.7	57.8	20.1	14.2	2,518	1,603
4 pecks	286	do	do	34	3	57.8	58.0	21.4	14.9	2,744	1,683
5 pecks	286	do	do	34	3	57.9	58.2	21.6	15.8	2,659	1,744

[1] Many weeds in the plat were due to poor stands in 1920 and 1922.

The experiment has not yet been conducted long enough for the results to be conclusive. Nevertheless, the data obtained indicate that the medium-early seedings (about September 1) are more likely to produce satisfactory results than early or late seedings. Regardless of the time of seeding, a rate of 3 pecks or more to the acre is better than lighter seedings.

NURSERY EXPERIMENTS

Nursery experiments at Akron have consisted chiefly of the testing of varieties and selections of winter wheat. Several thousand selections from Alton (Ghirka Winter) and the Crimean wheats have been made. Since 1917 probably 2,500 selections made at this and other stations have been sown in the winter-wheat nursery. Most of these were lost by winterkilling and soil blowing or were discarded after tests of several years proved them unpromising. A larger number of selections was made from Alton than from any other variety. The object of these selections was to obtain an awnless winter wheat equal in all other respects to the awned varieties now grown. Of the numerous selections made at Akron prior to 1920, a few are somewhat promising and are being grown in preliminary plat experiments. Some unusually promising selections of winter wheat made at Akron are now being grown in rod-row experiments. One of the most promising of these was made from Kanred (C. I. No. 5146).

SPRING WHEAT

VARIETAL EXPERIMENTS

Most of the spring-wheat varieties grown in plat experiments belong to the two main classes, durum and hard red spring. Varietal experiments conducted early in the history of the station proved that most of the white spring wheats are poorly adapted. In all, 63 varieties have been grown in plats during the 15-year period from 1908 to 1922, inclusive. Several lots or strains under the same name but from different sources or several selections of the same variety have been grown in some cases, so that the actual number of distinct varieties is somewhat less than 63.

Some of the varieties grown in 1908 were not continued in the experiments because of similarity to other varieties or strains or because of low yield or other undesirable characters. As yields of these varieties have been presented previously,[8] they will not be repeated here. These varieties included 7 durum wheats, 5 hard red spring wheats, and 5 white wheats. The annual yields of the remaining 46 varieties and strains, with average yields for the periods from 1908 to 1922, 1917 to 1922, and 1920 to 1922, inclusive, are presented in Table 15.

The data in Table 15 show that good yields were produced in 1908, 1910, 1912, 1914, and 1915. Fair yields were obtained in 1909 and 1920 and poor yields in 1913, 1916, 1917, 1921, and 1922, while failures were recorded for most of the varieties in 1911, 1918, and 1919.

Previous to 1917 the spring wheats were grown largely on summer fallow. Beginning with 1917 they have been grown in quadruplicated plats, two on fallow and two on cornland, which partly accounts for the lower yields recorded during the past six years. Had the 1920 crop been grown on fallow alone the yields would possibly have been equal to those of 1908 or 1915. In 8 of the 15 years—1911, 1913, 1916, 1917, 1918, 1919, 1921, and 1922—the spring-wheat yields were reduced by lack of moisture when it was most needed. As a rule, only the early varieties yield well at Akron. Spring wheats have not been injured seriously by rust in these experiments.

[8] McMurdo, George A. Cereal experiments at the Akron Field Station, Akron, Colo. U. S. Dept. Agr. Bul. 402, p. 20.

TABLE 15.—*Yields of spring-wheat varieties grown at the Akron Field Station, 1908–1922, inclusive*

Class and variety	C. I. No.	Acre yield (bushels)															Average		
		1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1908 to 1922	1917 to 1922	1920 to 1922
DURUM																			
Acme	5284													14.6	7.7	8.8			10.4
Akrona (Arnautka) Sel. 7–12	6881											[1]6.7	8.6	[1]20.4	10.2	10.2			13.6
Arnautka	1493	26.9	20.7	16.4	10.6	27.5	10.6	25.6	27.9	10.7	7.0	7.1	8.6	15.2	7.8	9.2	15.4	9.1	10.7
Arnautka (Sel. 6 P1.)	4064			19.5	15.7	37.0	10.6	25.0	27.6	11.4	6.5	6.4	5.4	13.8	7.2	7.4		7.8	9.5
Beloturka	1520	31.1	19.4	19.9	8.0	21.1	10.6	19.5	26.7	11.4	5.5	3.1	8.3	[1]20.2	8.5	9.6	14.9	9.2	12.8
Blé dur	1471	15.5	16.8	17.7	10.6	33.0	8.3	26.3	33.6										
Gharnovka	1447	29.1	20.9	25.0	9.2	36.5	3.3	23.6	22.2										
Golden Ball	6227												8.8	15.3	8.2				
Kahla	5549													[1]11.9	6.1	7.1			8.4
Kubanka	1354	27.2	18.0	21.3	11.7	19.8	13.6	22.6											
Do	1440	26.8	9.3	17.1	9.0	25.1	5.1	20.6	27.6	12.9	7.5	3.0	6.0	14.8	8.6	9.6	13.5	8.2	11.0
Do	1516			32.3	9.1	30.0	6.0	26.4	31.3										
Kubanka No. 8	4063									4.7	7.0								
Marouani	1593	22.9	14.2	19.2	10.6	18.9	14.1	23.9											
Mindum	5296															8.2			
Monad	3320										6.5	2.0	8.7	14.9	7.2	9.6		8.1	10.6
Peliss	1584	24.7	23.6	15.8	10.6	35.6	10.5	26.6	31.6	14.4	7.8	3.7	8.8	16.9	9.1	7.9	16.5	9.0	11.3
Pentad (D–5)	3322										7.8	2.5	6.5	15.7	8.4	8.7		8.3	10.9
Pererodka	1350	21.9	15.9	11.5															
Purple	3024	24.7	20.7	15.3	7.9	33.0	10.0	21.1											
Taganrog	1570	20.0											4.2	[1]23.5					
Velvet Don	1445	33.3	21.1	13.5	10.0	33.3	7.3	25.3	28.1										
Yellow Gharnovka	1444	32.8	25.5	15.0	10.8	34.2	5.3	22.5	31.2										
Unnamed	3143															12.7			
HARD RED SPRING																			
Cole Hybrid	4062	11.8	27.9	21.5	12.3	18.2	8.0	21.0											
Converse	4141		15.2	15.6	12.1	23.2	8.3	23.0	23.9	7.7	7.0	7.5	11.1	16.8	6.7	10.8	[2]13.6	10.0	11.4
Erivan	2397	19.3	26.3	15.1	11.9	20.7	12.0	19.3	19.5	7.8	9.2	10.5	12.9	[1]22.9					
Ghirka	1517	20.6	23.8	18.7	8.5	23.3	11.6	19.3	22.6	7.5	8.2	4.1	7.5	[1]17.9					
Glyndon	2873				9.4	17.3	8.0	16.6	16.2	7.2	6.6	2.5	4.3	14.2	4.0				
Haynes	2874								16.4	.8	4.9	1.0	2.7	[1]12.5	1.8				
Do	3020	25.2	15.3	19.8															
Kitchener	4800													15.9	5.7	7.3			9.6
Kota	6248													18.8	5.7	11.3			11.9
Laramie	6235												5.6	[1]13.5					
Manchuria	2492	18.2	23.3	25.0					21.2										
Marquis	3641						7.5	19.6	26.5	11.8	7.3	3.7	8.5	14.5	7.4	6.0		7.9	9.3
Norka	4377						8.6	16.3							4.4				
Pioneer	4324								28.7	6.9	8.0	9.1	13.9	15.5	7.6	9.4		10.6	10.8
Power	3697									1.6		1.2	4.7	[1]15.4	[1]6.4				
Prelude	4323								29.5	8.3	6.0	9.8	17.5	11.6	4.2	9.0		9.7	8.3
Preston	3081						9.6	18.3	26.2	7.2	6.9	2.3	5.9	[1]18.3	[1]3.0				
Red Bobs	6255													[1]12.5	6.3	11.1			10.0
Ruby	6047													[1]16.5	7.6	10.5			11.5
COMMON WHITE																			
Baart	1697														[1]6.0	12.7			
Galgalos	2398	21.8	19.8	20.5	19.6	20.5	14.1	21.6	24.4	10.5	9.2	10.7	5.8	18.3					
Hard Federation	4733															11.4			

[1] Grown on fallow only.
[2] Average of yields of Erivan (19.3 bushels) and Fretes (10.3 bushels), two similar varieties, are included or 1908, when Converse was not grown.

Four varieties of durum wheat have been grown during the entire 15-year period from 1908 to 1922, inclusive; but most of the varieties of common wheat which yielded well for the first 5 to 10 years had objectionable characters, such as poor quality of grain, shattering

heads, or weak straw. In some seasons the durum varieties have outyielded the common varieties, and in others the reverse has been true.

Table 16 shows the annual and average yields of 18 varieties of spring wheat grown on both fallow and cornland during the 6-year period from 1917 to 1922, inclusive. Figure 14 presents graphically the yields of the most important spring-wheat varieties grown in all

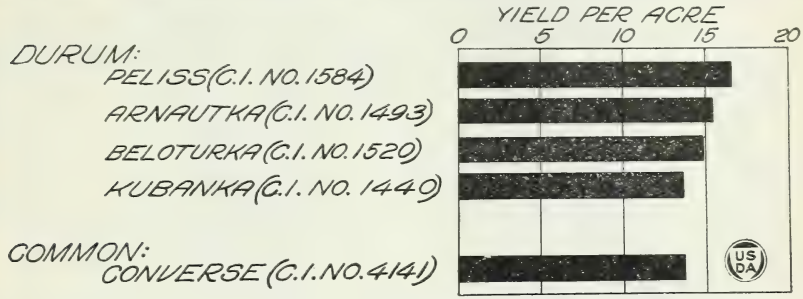

FIG. 14.—Average acre yields of five varieties of spring wheat at the Akron Field Station during the 15-year period, 1908–1922, inclusive

years. Agronomic data on 11 varieties grown on fallow and on cornland from 1917 to 1922 are presented in Table 17. From the results obtained with winter and spring wheat, it is concluded that seeding of spring wheat at Akron is not to be generally recommended. Even when sown as late as the latter part of October, winter wheat is apparently safer than spring wheat.

TABLE 16.—*Acre yields, in bushels, of spring-wheat varieties grown on fallow and on cornland at the Akron Field Station, 1917–1922, inclusive*

Class and variety	C. I. No.	Grown on fallow								Grown on cornland							
								Average								Average	
		1917	1918	1919	1920	1921	1922	1917 to 1922	1920 to 1922	1917	1918	1919	1920	1921	1922	1917 to 1922	1920 to 1922
DURUM																	
Peliss	1584	12.1	4.2	9.8	20.6	10.1	9.7	11.1	13.5	3.5	3.2	7.6	13.2	8.0	6.0	6.9	9.1
Arnautka	1493	10.4	7.8	12.2	17.7	8.9	10.8	11.3	12.5	3.6	6.5	4.9	12.7	6.6	7.7	7.0	9.0
Beloturka	1520	8.8	3.1	9.6	20.2	10.0	10.8	10.4	13.7	2.3	3.2	7.1	----	6.9	8.5	5.6	----
Pentad (D-5)	3322	12.9	1.9	6.5	18.9	9.5	10.2	10.0	12.9	2.8	3.2	6.4	12.4	7.2	7.3	6.6	9.0
Kubanka	1440	12.1	2.9	6.0	17.1	10.3	11.1	9.9	12.8	3.0	3.2	5.8	12.7	6.8	8.0	6.6	9.2
Monad	3320	9.6	1.9	9.4	18.6	8.1	11.7	9.9	12.8	3.4	2.1	7.9	11.2	6.3	7.4	6.4	8.3
Arnautka	4064	9.9	7.0	5.9	16.7	8.6	8.0	9.4	11.1	3.1	5.8	4.9	10.8	5.8	6.9	6.2	7.8
Akrona (Arnautka selection)	6881	----	----	----	20.4	12.5	12.9	----	15.3	----	----	----	----	7.8	7.5	----	----
Acme	5284	----	----	----	17.1	8.9	10.5	----	12.2	----	----	----	12.1	6.4	7.2	----	8.6
Kahla	5549	----	----	----	11.9	6.9	6.8	----	8.5	----	----	----	----	5.2	7.3	----	----
HARD RED SPRING																	
Pioneer	4324	11.8	10.1	13.3	17.1	9.5	11.4	12.2	12.7	4.4	8.2	14.3	14.0	5.7	7.2	9.0	9.0
Converse	4141	10.3	8.0	13.5	18.5	8.3	11.8	11.7	12.9	3.8	7.1	8.7	15.2	5.1	9.7	8.3	10.0
Prelude	4323	8.5	8.4	16.9	14.5	5.6	10.7	10.8	10.3	3.5	11.3	18.1	8.6	2.7	7.3	8.6	6.2
Marquis	3641	11.3	4.1	12.7	15.8	9.4	7.4	10.1	10.9	3.0	3.4	4.3	13.1	5.4	4.6	5.6	7.7
Kota	6248	----	----	----	20.4	7.2	13.1	----	13.6	----	----	----	17.2	4.1	9.6	----	10.3
Ruby	6247	----	----	----	16.5	10.0	11.6	----	12.7	----	----	----	----	5.2	9.3	----	----
Red Bobs	6255	----	----	----	12.5	8.1	12.7	----	11.1	----	----	----	----	4.4	9.6	----	----
Kitchener	4800	----	----	----	16.4	6.6	8.7	----	10.6	----	----	----	15.4	4.7	5.8	----	8.6

TABLE 17.—*Average agronomic data recorded on spring-wheat varieties grown on fallow and on cornland at the Akron Field Station, 1917–1922, inclusive*

Class and variety	C. I. No.	Dates of—		Height	Stem-rust infection	Bushel weight	Acre yield	
		Heading	Maturity				Grain	Straw
GROWN ON FALLOW								
Durum:				*Inches*	*Per cent*	*Pounds*	*Bushels*	*Pounds*
Peliss	1584	June 28	July 26	31	1—	59.5	11.1	1,851
Arnautka	1493	June 27	July 24	32	2—	58.3	11.3	1,797
Beloturka	1520	do	July 25	31	1—	57.9	10.4	1,817
Kubanka	1440	June 28	do	30	1—	58.2	9.9	1,601
Pentad (D–5)	3322	do	do	30	1—	58.2	10.0	1,702
Monad	3320	do	do	29	1—	58.0	9.9	1,687
Arnautka	4064	June 27	July 26	33	2—	57.7	9.4	1,739
Hard red spring:								
Converse	4141	June 28	July 22	29	5—	55.2	11.7	1,877
Pioneer	4324	June 26	July 20	30	5—	55.5	12.2	1,831
Prelude	4323	June 19	July 15	28	7—	55.5	10.8	1,166
Marquis	3641	June 29	July 26	28	3—	55.3	10.1	1,297
GROWN ON CORNLAND								
Durum:								
Peliss	1584	June 24	July 26	26	1—	56.8	6.9	1,096
Arnautka	1493	do	July 24	27	2—	58.3	7.0	1,133
Beloturka [1]	1520	do	July 23	24	2—	57.9	5.6	1,105
Kubanka	1440	June 25	July 25	25	1	57.9	6.6	1,180
Pentad (D–5)	3322	do	do	25	1—	56.5	6.6	1,224
Monad	3320	do	do	27	1—	58.0	6.4	1,298
Arnautka	4064	June 26	July 25	27	2	57.8	6.2	1,068
Hard red spring:								
Converse	4141	June 25	July 21	26	5—	55.1	8.3	1,302
Pioneer	4324	June 23	July 19	26	5—	54.6	9.0	1,313
Prelude	4323	June 17	July 14	25	3—	54.6	8.6	911
Marquis	3641	June 25	July 25	24	3—	55.0	5.6	1,032

[1] Not grown on cornland in 1920.

Although the best durum varieties have produced yields averaging a little better than the best hard red spring wheats, the spread in the price between durum and hard red spring wheat usually is sufficient to warrant recommending the sowing of the hard red spring varieties if spring wheat is to be grown. Spring wheat might be used as a catch crop to reseed ground on which winter wheat has winterkilled or been blown out.

Of the varieties of durum wheat grown for six years or longer Peliss and Arnautka (C. I. No. 1493) have produced the best yields. Kubanka (C. I. No. 1440), Beloturka, and Arnautka (C. I. No. 4064) are apparently inferior to Peliss and to Arnautka (C. I. No. 1493). The rust-resisting strains, Pentad (D–5) and Monad (D–1), have not yielded well. Yields of varieties grown three years or longer indicate that Akrona (C. I. No. 6881), the early Arnautka selection, is equal if not superior to Peliss and Arnautka (C. I. No. 1493), and that Acme and Kahla are inferior. However, three years' data can not be considered conclusive. Figure 15 shows heads of Peliss and Arnautka durum wheat, which are leading varieties at the Akron Field Station.

No hard red spring varieties have been grown during the entire period from 1908 to 1922, but those grown for long periods have produced yields averaging slightly less than the best durum wheats. During the 6-year period from 1917 to 1922, inclusive, several hard red spring varieties outyielded the durums. Pioneer, Converse (Red Russian), and Prelude have been the highest yielding hard red spring varieties for this period. As these wheats mature very early, they have escaped the effects of drought much better than has Marquis.

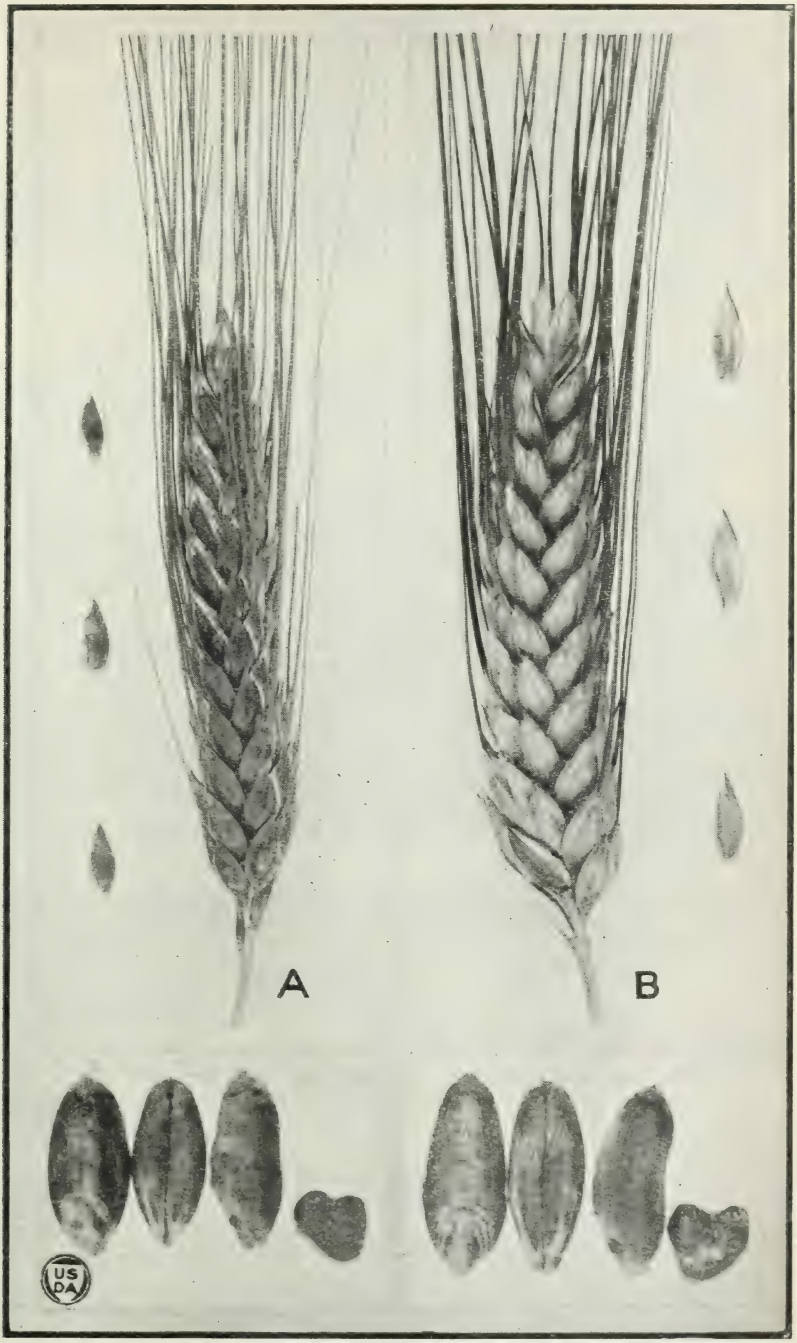

FIG. 15.—Spikes, glumes, and kernels of Arnautka (A) and Peliss (B) wheats. Spikes, face view, natural size; glumes from lower, central, and upper portions of spike, natural size; kernels in three positions and in transverse section, magnified 3 diameters.

Among varieties of hard red spring wheat grown for at least three years, Kota ranks first. It has been grown for a period too short to justify recommending it for seeding in this section, and it is perhaps slightly later in maturing than is desirable.

In general, the spring-wheat varieties have headed slightly earlier on cornland than on fallow, but have matured at about the same time. Most varieties have grown from 3 to 6 inches taller on fallow. Stem-rust infection has been light and has been about the same on the two soil treatments. Variation in bushel weight has been slight except in Peliss and Pentad, which showed a materially higher bushel weight when grown on fallow. Yields of both grain and straw of all varieties have averaged higher on fallow.

RATE-OF-SEEDING EXPERIMENTS

With the exception of 1917, rate-of-seeding experiments with durum wheat have been conducted each year since 1911. From 1911 to 1914, inclusive, Arnautka (C. I. No. 4064) was sown. In 1915 the variety used was Beloturka (C. I. No. 1520), while in 1916 and in the five years from 1918 to 1922, inclusive, Arnautka (C. I. No. 1493) was sown. The experiments were conducted largely on single plats on summer fallow from 1911 to 1916. In 1918, 1919, and 1920 they were grown on duplicate plats on fallow and on cornland and in 1921 and 1922 on single plats on fallow. The rates of seeding have ranged by 1-peck intervals from 1 to 7 pecks per acre, but the wheat has not been sown at all of the rates during all years of the experiment.

In 1915 a rate-of-seeding experiment was conducted with the white spring wheat, Galgalos (C. I. No. 2398) and in 1916 with the hard red spring variety, Marquis (C. I. No. 3641). The rates of seeding in these experiments ranged by 1-peck intervals from 2 to 6 pecks. An unusually heavy seeding of 16 pecks was made of Marquis in 1916.

The yields obtained in the rate-of-seeding experiments with durum wheat on fallow are shown in Table 18 and the average agronomic data in Table 19.

TABLE 18.—*Yields of durum wheat grown in rate-of-seeding experiments on fallow at the Akron Field Station, 1911–1922, inclusive* [1]

Rate of seeding per acre	Acre yield (bushels)												
	1911	1912	1913	1914	1915	1916	1918	1919	1920	1921	1922	Average 1911 to 1922	Average 1912 to 1916, 1919, 1921–22
1 peck				14.6						6.4	5.2		
2 pecks	9.9	41.0	7.3	18.0	30.0	8.0	8.7	8.3		7.1	4.8		15.6
3 pecks	9.7	37.3	8.6	19.6	29.5	9.8	8.1	12.2	19.4	7.4	6.2	15.3	16.3
4 pecks	10.7	37.0	10.9	20.0	29.5	11.0	7.8	11.9	17.7	7.5	7.7	15.6	16.9
5 pecks	12.6	30.3	11.6	22.0	29.5	11.2	7.6	10.6	17.1	8.4	7.6	15.3	16.4
6 pecks		28.3	11.1	21.3	30.2	12.2		10.0	18.3	10.2	8.6		16.5
7 pecks		27.0	11.6	21.0									

[1] Experiment not conducted in 1917. The rate-of-seeding experiments were conducted on both fallow and cornland in 1918, 1919, and 1920, but yields from fallow only are reported here. Yields on cornland were somewhat less than those on fallow. The varieties used were: From 1911 to 1914, inclusive, Arnautka (C. I. No. 4064); 1915, Beloturka (C. I. No. 1520); and in 1916 and 1918 to 1922, inclusive, Arnautka (C. I. No. 1493).

TABLE 19.—*Average agronomic data recorded on durum wheat grown in rate-of-seeding experiments on fallow at the Akron Field Station, 1911–1922, inclusive, except 1917*

Rate of seeding	Dates of—		Height	Stem-rust infection	Bushel weight	Acre yield [1]	
	Heading	Maturity				Grain	Straw
			Inches	*Per cent*	*Pounds*	*Bushels*	*Pounds*
2 pecks [2]	June 25	July 28	38	2—	59.2	15.6	2,210
3 pecks	June 26	do	37	2	58.7	16.3	1,902
4 pecks	do	do	37	2	58.8	16.9	2,116
5 pecks	do	do	36	2	58.8	16.4	2,071
6 pecks [3]	June 27	July 27	36	2+	57.5	16.5	2,225

[1] Omitting data for 1911, 1918, and 1920.
[2] Average for 10 years only, 1920 omitted.
[3] Average for 9 years only, 1911 and 1918 omitted.

Several interesting facts are brought out by these data: (1) The net yields have not been increased by sowing at a rate in excess of 4 pecks per acre; (2) thin seeding will not increase the yields or prevent failure in dry seasons; (3) seedings up to 6 pecks to the acre did not reduce the yields appreciably.

It has been commonly assumed that durum wheat should be sown at the rate of 4 to 5 pecks per acre on dry land, whereas 3 pecks is regarded as the best rate for hard red spring wheat. The higher rate for durum wheat has been recommended because of the large size of the durum kernels and because durum wheat does not tiller as freely as hard red spring wheat. The slight differences in yields shown in Table 18 indicate that about the same results may be expected on the average from any rate of seeding between 3 and 6 pecks.

The proportion of straw to grain has not been exactly the same for the different rates of seeding. In the plats sown at the lower rates, weeds have increased the total weight of the crop. The data indicate that plats sown at the heavier rates headed slightly later and matured slightly earlier than those sown at the thinner rates, but this was not true in all seasons. The wheat in plats sown at rates of 5 and 6 pecks per acre was shorter than that on the other plats. The bushel weight of the grain from the plats sown at the 2-peck rate was slightly greater than that from the plats sown at the heavier rates.

The average yields obtained on cornland in 1918, 1919, and 1920 were as follows: From the 3-peck rate, 7.6 bushels; from the 4-peck rate, 8.6 bushels; and from the 5-peck rate, 8.7 bushels.

In 1915 Galgalos, a white spring wheat, was sown at rates ranging from 2 to 6 pecks to the acre. The 2-peck and 4-peck rates yielded 20 bushels each; the 3-peck rate, 18.6 bushels; the 5-peck rate, 21.2 bushels; and the 6-peck rate, 20.8 bushels. In 1916 Marquis, a hard red spring wheat, was sown at rates ranging from 2 to 6 pecks and also at the extremely high rate of 16 pecks to the acre. The yields obtained were: From the 2-peck rate, 9.8 bushels; the 3-peck rate, 11.8 bushels; the 4-peck rate, 10.5 bushels; the 5-peck rate, 10.8 bushels; the 6-peck rate, 6.7 bushels; and the 16-peck rate, 10 bushels. These data are insufficient to justify drawing conclusions; but, like most other data from similar experiments, they indicate that rates of seeding within reasonable limits affect yields very slightly.

NURSERY EXPERIMENTS

Many varieties and selections of spring wheat have been grown in nursery rows, but because of their apparent lack of promise have not been grown in plats. A large number of foreign varieties have been tested in a preliminary way and later discarded. Most of the nursery experiments with spring wheat have consisted of the testing of pure-line selections made at Akron from both durum and hard red spring wheats. A number of strains resulting from crosses have been grown. Selections from Arnautka durum wheat have appeared to be most promising. Two of these, Arnautka (C. I. No. 4064) and Akrona (C. I. No. 6881), have been grown in plats at this and other stations. The yields of Arnautka (C. I. No. 4064) in plat experiments have been less than those of the parental strain. Akrona (C. I. No. 6881) produced fair yields in plat experiments in 1920, 1921, and 1922. As it appears to be slightly earlier than the other durums grown, it may prove valuable. One selection of hard red spring wheat made at Akron, Norka (C. I. No. 4377), although otherwise inferior, has proved to be especially resistant to certain strains of leaf rust.

COMPARISON OF SPRING AND WINTER WHEATS

A comparison of the annual and average yields of Turkey and Kharkof winter wheats, Peliss and Arnautka durum wheats, and Converse (Red Russian) hard red spring wheat for the 15-year period from 1908 to 1922, inclusive, is shown in Table 20. The average yields of these varieties for this period are shown graphically in Figure 16. The winter-wheat varieties outyielded the durum wheats in 10 out of the 13 years in which a crop was obtained. Winter wheat was a failure in 1909, and no winter wheat was sown in the cereal experiments in the fall of 1918. Converse wheat was not grown in 1908, but the average of the yields of two similar varieties, Erivan and Fretes, is included in the table.

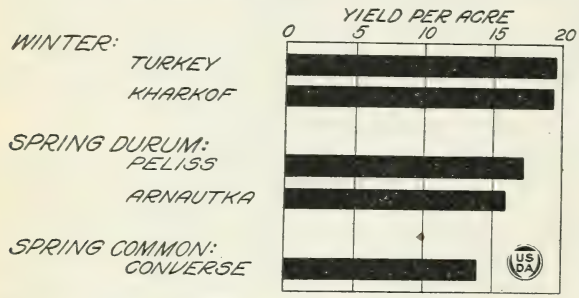

FIG. 16.—Average acre yields of leading varieties of winter and spring wheat at the Akron Field Station during the 15-year period, 1908–1922, inclusive, except 1919

The average yields of Turkey and Kharkof have been 19.5 and 19.4 bushels per acre, respectively, as compared with 17.1 bushels produced by Peliss in the same years, 15.9 bushels by Arnautka, and 13.8 bushels by Converse.

The crops of winter wheat in 1915, 1916, 1920, and 1922 were reduced by soil blowing and winterkilling. Except in 1915, however, winter wheat outyielded spring wheat in each of these years. A complete failure of winter wheat resulted in 1909 from a combination of soil blowing, winterkilling, and too severe treatment of the seed for smut.[9] Spring wheat averaged higher than winter wheat in 1908,

[9] The 1909 yields of winter wheat are included as 0 in computing averages. It would have been possible to seed this land to spring wheat and thus avoid a total loss of crop. Had this been done the difference in the average yield of winter wheat over that of spring wheat would have been greater for the 15-year period than that shown in the tables included in this bulletin. There are arguments for and against either method of computing yields.

1914, and 1915. The hard red spring wheat, Converse, outyielded both of the durum varieties in 1911, 1918, 1919, and 1922. In 1920 it outyielded Arnautka and practically equaled Peliss. With the exception of 1920 these were all droughty seasons.

TABLE 20.—*Yields of two varieties of hard red winter wheat, two of durum wheat, and one of hard red spring wheat grown at the Akron Field Station, 1908–1922, inclusive*

Group and variety	C. I. No.	Acre yield (bushels)															Average, 1908 to 1922[1]
		1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	
Hard red winter:																	
Turkey	1571	19.8	[2] 0	29.5	11.7	43.1	[3] 7.3	25.1	28.1	31.7	8.5	18.4	([4])	21.7	15.3	12.7	19.5
Kharkof	1583	19.3	[2] 0	29.8	14.2	37.5	16.6	26.0	29.2	26.2	16.9	12.3	([4])	16.1	13.0	14.2	19.4
Durum:																	
Peliss	1584	24.7	23.6	15.8	10.6	35.6	10.5	26.6	31.6	14.4	7.8	3.7	8.8	16.9	9.1	7.9	17.1
Arnautka	1493	26.9	20.7	16.4	10.6	27.5	10.6	25.6	27.9	10.7	7.0	7.1	8.6	15.2	7.8	9.2	15.9
Hard red spring:																	
Converse	4141	[5] 14.8	15.2	15.6	12.1	23.2	8.3	23.0	23.9	7.7	7.0	7.5	11.1	16.8	6.7	10.8	13.8

[1] Not including 1919.
[2] All winter wheat was destroyed by winterkilling.
[3] Yield from a selection of Turkey (C. I. No. 1571); original strain was not grown.
[4] No winter-wheat plats were sown in the fall of 1918.
[5] Converse was not grown in 1908, but averages of two similar varieties, Erivan and Fretes, are included.

Since 1917 the wheat varieties have been grown in duplicate plats on fallow and on cornland. The average yields of the most important varieties on each soil preparation are shown graphically in Figure 17. Winter wheat on both fallow and cornland has outyielded spring wheat. All of the varieties of winter and spring wheat, except Kanred winter wheat, have yielded about one-third higher on fallow than on cornland. Kanred has yielded only 14 per cent less on cornland than on fallow, but has been grown in the experiments only five years. When grown for a longer period, possibly a greater difference will result. The unusually high yield of Kanred on cornland is partly accounted for by the variety being favorably located to receive run-off in 1920.

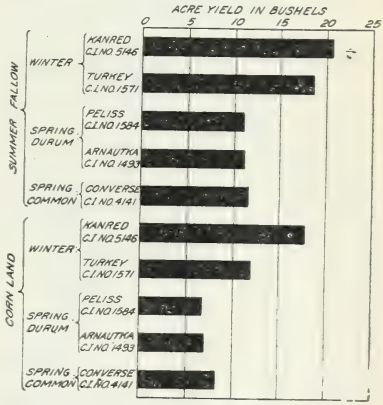

FIG. 17.—Average acre yields of leading varieties of winter and spring wheat at the Akron Field Station when grown on fallow and on cornland in the five years, 1917–1922, inclusive

From the results obtained it is evident that winter wheat yields higher than spring wheat almost every year. The winter-wheat crop may be injured by soil blowing and winterkilling, but with a fair stand of plants winter wheat will outyield spring wheat in an average season. The advantage of the best winter wheat over the highest yielding spring wheat, Peliss durum, as shown in Table 20, is 2.4 bushels for the 14-year period. In the 5-year period, 1917, 1918, and 1920 to 1922, Kanred winter wheat has outyielded Peliss spring wheat by nearly 10 bushels to the acre when both were grown on fallow and by 11 bushels when grown on cornland.

In seasons when winter wheat fails, because of unfavorable conditions, the land may be sown to spring wheat. Otherwise, the seeding of spring wheat can not be advised if conditions are at all favorable for seeding winter wheat.

EXPERIMENTS WITH OATS

The yields of oats are usually less in pounds per acre than the yields of barley. Oats are most profitably grown in this district when sown on cornland very early in the spring. Drought may prevent heading, in which case the crop can be cut for hay. As a rule oats do not produce so large a crop as barley, and for that reason barley is more generally grown.

VARIETAL EXPERIMENTS

During the 15-year period from 1908 to 1922, inclusive, 28 varieties and strains of spring oats have been grown in plats. It was soon found that only early varieties were suited to the region, but a few midseason and late varieties were continued in the experiments for comparison. Only three varieties of oats have been grown during all of the 15 years. Several early varieties and strains were added to the experiments in 1920 and in 1922. The annual and average yields of the oat varieties are shown in Table 21, except those of eight varieties grown only one or two years between 1908 and 1915. Yields of most of these eight varieties were reported in Department Bulletin 402.

TABLE 21.—*Yields of oat varieties grown at the Akron Field Station in one or more years, 1908–1922, inclusive*

Group and variety	C. I. No.	Acre yield (bushels)															Average		
		1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1908 to 1922	1912 to 1922	1916 to 1922
EARLY YELLOW OR WHITE																			
Albion (Iowa No. 103)	729									8.6	24.0	8.2	12.3	31.4	24.6	23.8			19.0
Aurora	831														30.2	27.1			
Early Champion	553	41.8	25.0	21.9															
Kherson	459	52.8	33.1	34.6	12.4	38.5	36.1	66.9	85.0	16.8	14.7	6.1	11.2	39.2	24.7	25.7	33.2	33.2	19.8
Kherson (Nebr. No. 21)	841												14.1	40.9	27.4	21.5			
Kherson (Sel. No. 6–2–18)	459															24.4			
Kherson (Sel. No. 8–1–18)	459															22.9			
Peru	170				2.0	34.5	20.6	50.5	78.0										
Richland (Iowa No. 105)	787									12.5									
Sixty-Day	165	42.9	37.2	34.8	3.3	38.0	28.3	65.0	82.6	12.5	14.9	6.3	11.9						
Sixty-Day (Sel. No. 4P2)	788			32.0	4.2	40.0	26.2	61.2	74.2	9.3									
EARLY BLACK OR RED																			
Colburt (Burt selection)	2019					48.2	36.8	63.1	82.6	11.7	13.9	5.8	9.4	32.0	30.5	28.2		32.9	18.8
Fulghum	708														27.0	30.5			
MIDSEASON																			
Black American	549						35.6	60.0					17.6	52.5	20.8	12.5			
Canadian	444	19.2	53.1	29.4															
Colorado No. 37	619	36.8	55.6	29.9	32.5	30.9	32.5	53.7	79.2	7.4	7.9	4.8	4.8	44.4	15.6	5.6	29.4	26.1	12.9
Golden Rain	493									5.1	7.6	5.3	3.3	53.0	16.7	7.0			14.0
Lincoln	738						41.2	61.2	67.8	9.4	9.4	5.7	5.9						
Swedish Select	134	62.5	50.7	29.4	22.3	30.2	27.5	48.7	69.4	10.5	9.2	2.7	4.3	47.9	15.9	9.5	29.4	25.1	14.3
LATE																			
White Tartar	300	19.7				23.4	23.7	43.1	65.0	0.7	4.1	3.4	2.1	37.1	9.4	3.0		19.5	8.5

Table 21 shows that good yields of oats were obtained from the early varieties in 1908, 1909, 1910, 1912, 1914, 1915, and 1920. Fair yields were produced in 1913, 1921, and 1922 and poor yields or failures resulted in the other years. In 1909, 1911, 1913, and 1920 the midseason and late varieties were somewhat favored by late rains and produced higher yields than the early varieties.

In most years when the rainfall was low the early varieties outyielded the later ones. The Kherson (C. I. No. 459) has produced the highest average acre yield, 33.2 bushels, during the 15-year period. This is the only early oat grown throughout the entire period. The average date of maturity is July 17, the average height 28 inches, average bushel weight 31 pounds, and average acre yield of straw 1,295 pounds. A panicle and spikelets of Kherson oats are shown in Figure 18.

FIG. 18.—Panicle and spikelets of the Kherson oat, the leading variety at the Akron Field Station

Two midseason varieties grown in all years, Swedish Select and Colorado No. 37, yielded about 4 bushels less. They headed and matured 10 to 12 days later than Kherson and averaged 3 inches taller. The bushel weight was 33 pounds, as compared with 31 pounds for Kherson. The yield of straw was considerably greater than that of Kherson, being 1,578 pounds to the acre for Colorado No. 37 and 1,616 pounds for Swedish Select. The greater height and higher yield of straw produced by these varieties about equalize the 4-bushel advantage in yield of grain in favor of Kherson. The average yields of the three varieties grown during the 15-year period are shown graphically in Figure 19.

Colburt (C. I. No. 2019), a selection from Burt, has produced good yields during the 11 years it has been grown in plats. It ranks next to Kherson in yield during this period. This selection is unlike most Burt strains, in that the kernels are brown or black in color and the strain breeds compar-

atively true. Albion (Iowa No. 103), a white selection from Kherson, has yielded fairly well during the period it has been included. The earlier varieties have been able to outyield the later varieties because of their ability to escape drought. The extreme earliness of certain selections from Burt and some of the most recent introductions, such as Fulghum and Kanota, may give them exceptional value in this section.

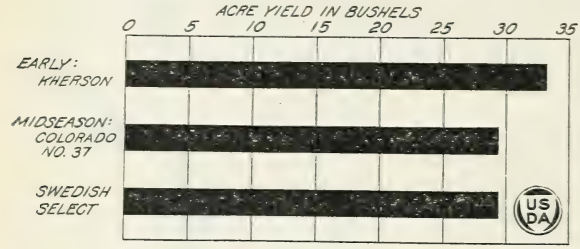

FIG. 19.—Average acre yields of three varieties of oats grown at the Akron Field Station during the 15-year period, 1908–1922, inclusive

Table 22 shows the yields of the oat varieties grown during the 6-year period from 1917 to 1922 on fallow and on cornland. These data show that Albion has outyielded all other varieties during this period. Table 23 shows the average data recorded on dates of heading and maturity, height, bushel weight, and yields of grain and straw for the seven varieties of oats which were grown during the 6-year period.

TABLE 22.—*Yields of seven oat varieties grown on fallow and on cornland at the Akron Field Station, 1917–1922, inclusive*

Group and variety	C. I. No.	Acre yield (bushels)												
		Fallow							Cornland					
		1917	1918	1919	1920	1921	1922	Average	1917	1918	1919	1920	1921	1922	Average
Early:															
Albion (Iowa No. 103)	729	26.2	11.9	16.4	32.4	29.3	30.3	24.4	21.8	4.5	8.2	30.4	19.9	17.3	17.0
Colburt (Burt selection)	2019	18.2	7.8	14.4	32.4	34.5	35.9	23.9	9.6	3.9	4.3	31.6	26.4	20.6	16.1
Kherson	459	16.4	7.4	17.0	39.1	30.3	29.6	23.3	12.9	4.9	5.4	39.3	19.2	21.9	17.3
Midseason:															
Colorado No. 37	619	9.9	8.0	8.9	48.4	18.5	7.4	16.9	5.8	1.7	.6	40.4	12.8	3.9	10.9
Golden Rain	493	11.3	7.6	6.2	55.6	18.9	7.3	17.8	3.9	3.1	.4	50.4	14.5	6.8	13.2
Swedish Select	134	11.3	3.3	7.0	47.0	20.1	12.5	16.9	7.2	2.1	.6	48.8	11.8	6.6	12.9
Late:															
White Tartar	300	4.9	5.2	3.5	34.0	11.9	4.1	10.6	3.3	1.6	.6	40.2	6.9	1.9	9.1

Colburt, the Burt selection made at the Akron Field Station, headed only about two days earlier than Kherson and the white selection from Kherson known as Albion, but matured nearly a week earlier. The midseason and late varieties headed a week to 10 days later than Kherson and matured 10 days to 2 weeks later. The maturity of the later varieties was hastened in some years by dry weather. The previous treatment of the land made no appreciable difference in the dates of heading and ripening, but all varieties grew taller on fallow than on cornland. The difference in height was more marked in the midseason and late than in the early varieties. Yields of both grain and straw were heavier on fallow than on cornland. In this six-year period Albion produced practically as much straw as any of the later varieties, materially exceeding Kherson in this respect.

In the fall of 1907 a plat of Boswell winter oats was sown at Akron. Although the winter survival was low, the plat yielded at the rate of 15.7 bushels per acre. The variety has been sown five other years, but each time the plants have entirely winterkilled.

TABLE 23.—*Average agronomic data recorded on seven varieties of oats grown on fallow and on cornland at the Akron Field Station, 1917–1922, inclusive*

Group and variety	C. I. No.	Dates of—		Height	Bushel weight	Acre yield	
		Heading	Maturity			Grain	Straw
GROWN ON FALLOW							
Early:				*Inches*	*Pounds*	*Bushels*	*Pounds*
Albion (Iowa No. 103)	729	June 23	July 16	28	31	24.4	1,350
Colburt (Burt selection)	2019	June 21	July 10	24	33	23.9	1,291
Kherson	459	June 24	July 16	27	30	23.3	1,060
Midseason:							
Colorado No. 37	619	June 30	July 28	30	30	16.9	1,326
Golden Rain	493	July 5	July 29	32	35	17.8	1,368
Swedish Select	134	July 2	July 27	30	32	16.9	1,156
Late:							
White Tartar	300	July 3	Aug. 1	31	32	10.6	1,217
GROWN ON CORNLAND							
Early:							
Albion (Iowa No. 103)	729	June 23	July 16	25	30	17.0	922
Colburt (Burt selection)	2019	June 21	July 10	23	32	16.1	883
Kherson	459	June 24	July 16	25	30	17.3	838
Midseason:							
Colorado No. 37	619	June 30[1]	July 26	23	28	10.9	733
Golden Rain	493	July 1[1]	July 29	25	32	13.2	792
Swedish Select	134	June 30[1]	July 27	25	33	12.9	676
Late:							
White Tartar	300	July 6[1]	July 31	25	32	9.1	[2] 912

[1] In some years these varieties did not head fully. [2] Large yields due to presence of many weeds.

RATE-OF-SEEDING EXPERIMENTS

Rate-of-seeding experiments with oats were conducted during nine seasons. Good yields were obtained in 1912, 1914, and 1915. Fair yields were obtained in 1913 and poor yields or failures resulted in 1911, 1916, 1917, 1918, and 1919. The rates of seeding varied by 1-peck intervals from 2 to 6 pecks, but only four different rates were sown during all of the years. The variety used in the experiments was Kherson (C. I. No. 459). The yields obtained are shown in Table 24. The highest average yields were obtained from sowing the oats at the rate of 6 pecks per acre, with slight gradual decreases from sowing at lower rates. The difference in average yield from the 3-peck and 6-peck rates during the eight-year period from 1912 to 1919, inclusive, was only 2.7 bushels to the acre.

TABLE 24.—*Yields obtained in a rate-of-seeding experiment with Kherson oats grown at the Akron Field Station, 1911–1919, inclusive*

Rate of seeding	Acre yield (bushels)										
	1911	1912	1913	1914	1915	1916	1917	1918	1919	Average	
										1911 to 1919	1912 to 1919
1 peck				57.5							
2 pecks	6.9	46.9	30.0	74.4	85.0	11.5	16.2	5.5	10.6	31.9	35.0
3 pecks	10.6	61.7	23.1	71.8	86.9	15.6	19.5	6.4	13.9	34.4	37.4
4 pecks	13.1	40.0	40.6	84.4	87.5	16.8	23.0	6.1	11.2	35.9	38.7
5 pecks	13.7	71.9	25.0	65.0	90.0	19.5	24.3	7.7	13.2	36.7	39.4
6 pecks		71.9	18.2	73.8	90.6	20.2	25.3	6.4	14.0		40.1
7 pecks								7.9	14.0		

Table 25 shows the average dates of heading and ripening, the height, bushel weight, and acre yields in pounds of straw and bushels of grain in the rate-of-seeding experiment. Increase in the seeding rate resulted in earlier heading and maturity. The height of plant and the bushel weight did not vary appreciably with the seeding rate. The acre yield of straw varied inversely with the rate of seeding. This may be partly accounted for by the presence of numerous weeds in the plats sown at the lower rates. The yields of grain increased with the increased rates of seeding and indicate clearly that the heavier seeding rates of 4 to 6 pecks per acre are better than seeding rates of 2 and 3 pecks per acre.

TABLE 25.—*Average agronomic data recorded on Kherson oats grown in a rate-of-seeding experiment at the Akron Field Station, 1911–1919, inclusive*

Rate of seeding	Dates of—		Height	Bushel weight	Acre yield	
	Heading	Maturity			Grain[1]	Straw
			Inches	*Pounds*	*Bushels*	*Pounds*
2 pecks	June 27	July 19	28	29	35.0	1,651
3 pecks	...do...	...do...	29	29	37.4	1,613
4 pecks	June 26	...do...	29	29	38.7	1,522
5 pecks	...do...	July 18	28	30	39.6	1,472
6 pecks[2]	June 27	...do...	28	30	40.1	1,460

[1] Average for the 8-year period from 1912 to 1919, inclusive.
[2] Average for the 8-year period from 1912 to 1919; not sown at this rate in 1911.

NURSERY EXPERIMENTS

The growing of head selections of oats was begun in 1908 and has been continued almost every year since. The most promising selection so far made at Akron, which is grown to any extent, is one from Burt (C. I. No. 293). This selection, No. 293–6–09, made by Wilson G. Shelley, has now been named "Colburt" (C. I. No. 2019). It has brown to black kernels, is of the *sativa* type, breeds comparatively true, and has yielded next to Kherson over the 11-year period from 1912 to 1922, inclusive. Several hundred selections of Burt and Kherson oats are now being grown in nursery rows and selection plats. Some of these selections appear to be especially promising.

EXPERIMENTS WITH BARLEY

The acre yields of the best varieties of barley have been greater than those of any of the other cereals grown for long periods. Most of the barley varieties mature slightly earlier than oats or wheat, which permits sowing the crop at a later date. Barley grown in this district is used exclusively as a feed crop and is mostly fed on the farms where grown. Its market value is therefore of minor importance.

Winter barley has been sown several years, but has never survived the winter sufficiently well to justify growing it.

VARIETAL EXPERIMENTS

Since 1908, 30 varieties and strains of spring barley have been grown in the varietal experiments. Only three varieties were grown during the entire period; eight varieties were grown continuously

during the six years from 1917 to 1922, inclusive. The yields of all varieties are shown in Table 26, except those of 7 varieties grown during only one or two years previous to 1917. Yields of these varieties were reported in Department Bulletin 402. Table 27 presents the yields of the eight varieties grown on fallow and on cornland during the six-year period from 1917 to 1922, inclusive. Average agronomic data on these varieties are shown in Table 28. Average yields of the three varieties grown during the entire 15-year period are shown graphically in Figure 20.

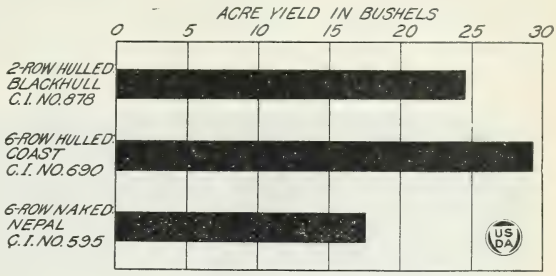

FIG. 20.—Average acre yields of three varieties of barley grown at the Akron Field Station during the 15-year period, 1908–1922, inclusive

TABLE 26.—*Yields of varieties of spring barley grown at the Akron Field Station, 1908–1922, inclusive* [1]

Group and variety	C. I. No.	Acre yield (bushels)															Average	
		1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1908 to 1922	1917 to 1922
2-rowed hulled:																		
Blackhull	878	25.4	20.1	23.8	5.8	26.6	25.4	42.9	77.1	19.7	19.9	11.0	12.9	14.5	16.2	27.1	24.6	16.9
Do	2087	----	----	----	----	----	----	----	----	----	----	----	----	----	15.2	----	----	----
Hanna	24	----	----	23.5	12.9	43.1	18.3	40.7	72.2	----	----	----	----	----	----	----	----	----
Do	203	34.2	22.2	27.9	14.3	39.7	28.1	42.5	70.5	20.9	10.4	4.2	7.4	----	----	----	----	----
Hannchen	531	47.8	20.7	28.2	10.4	52.0	22.3	52.7	----	----	----	----	----	----	----	----	----	----
Do	602	----	----	----	----	----	----	----	----	----	----	----	----	----	----	13.5	----	----
Orel	351	----	----	----	----	----	----	----	----	----	14.9	7.5	9.7	37.5	14.9	14.4	----	16.5
Do	2190	----	----	----	----	57.3	32.0	42.5	73.3	----	----	----	----	----	----	----	----	----
Primus	532	----	----	32.3	2.3	17.9	6.6	42.1	----	----	----	----	----	----	----	----	----	----
White Smyrna	195	----	----	----	----	----	----	----	----	20.3	19.6	12.2	11.0	26.1	17.7	23.6	----	18.4
Do	658	----	----	----	27.5	35.8	20.4	70.4	80.9	19.7	----	----	----	----	----	----	----	----
Do	2080	----	----	----	----	65.1	21.1	73.3	75.7	----	----	----	----	----	----	----	----	----
Do	2642	----	----	----	----	----	----	----	86.0	23.9	17.1	13.7	10.3	28.5	18.2	26.2	----	19.0
2-rowed naked:																		
Baku	[2] 709	----	----	----	----	27.7	6.8	----	----	----	9.1	5.8	8.5	18.9	15.1	11.8	----	11.5
6-rowed hulled:																		
Coast	690	38.6	32.8	25.6	16.7	38.5	22.5	59.3	79.1	20.8	17.8	8.1	10.2	28.0	20.8	22.7	29.4	17.9
Horsford	877	31.9	22.3	21.2	7.9	30.0	16.5	24.0	----	8.8	11.1	5.2	6.6	17.0	16.8	16.4	----	12.2
Manchuria	[3] 244	----	21.5	18.4	15.2	34.6	25.4	40.0	----	----	----	----	----	----	----	----	----	----
Nakano Wase	754	----	----	----	----	----	----	----	----	----	----	5.5	4.4	----	----	----	----	----
Composite	1147	----	----	----	----	----	21.6	44.5	66.0	14.8	----	----	----	----	----	----	----	----
6-rowed naked:																		
Himalaya	[2] 620	----	----	----	----	----	----	----	----	----	----	----	----	----	15.3	16.1	----	----
Nepal	[2] 595	25.1	25.8	19.4	.6	18.8	6.8	41.6	56.0	7.0	7.2	3.0	7.2	19.7	13.3	13.0	17.6	10.6

Previous to 1917 the barley plats were grown largely on fallow. Beginning in 1917 the varieties have been grown in duplicate plats on fallow and on cornland.

[2] Yields computed at 48 pounds per bushel, as for hulled varieties.

[3] Reported under C. I. No. 642 in U. S. Dept. of Agr. Bul. 402.

High yields of barley were obtained in 1908, 1909, 1910, 1912, 1914, and 1915 (Table 26). Fair yields were harvested of the better varieties in 1913, 1916, 1920, 1921, and 1922. During the other seasons the yields were small or almost complete failures resulted. The fluctuations in yield have resulted from differences in seasonal precipitation.

Awned barleys have outyielded both awnless and hooded varieties. The highest yielders include both six-rowed and two-rowed varieties. Coast has been the best yielder among the six-rowed varieties, and Smyrna (C. I. No. 2642) has been the highest yielding two-rowed sort grown during five or more years. The earliness of these varieties has enabled them to escape drought injury to a considerable extent and consequently they have yielded well. In seasons of favorable

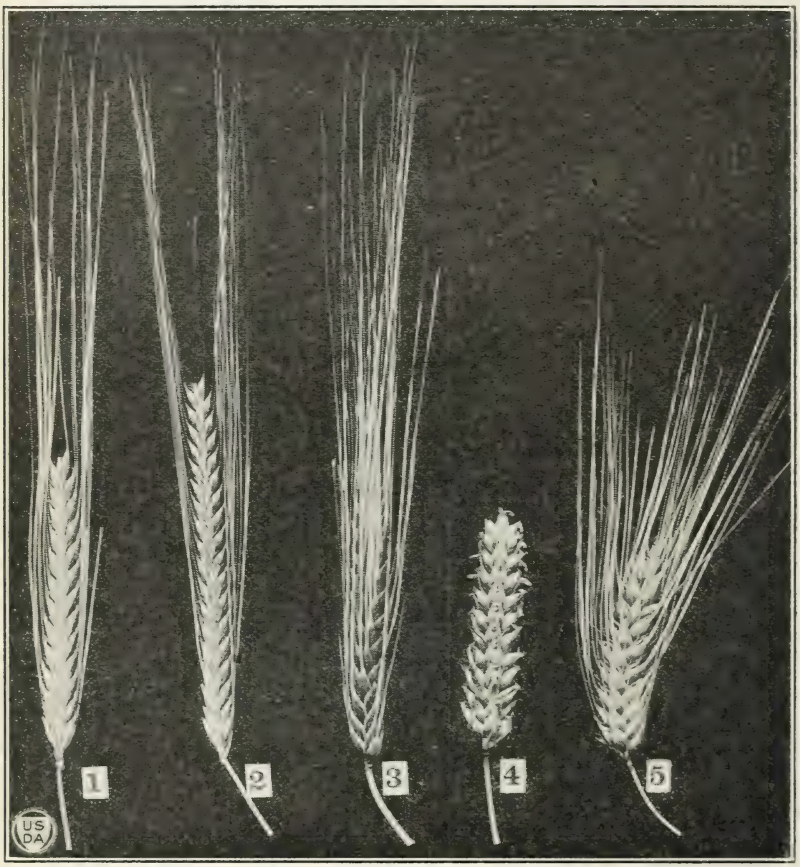

FIG. 21.—Spikes of varieties of barley grown at the Akron Field Station: 1, White Smyrna; 2, Hannchen; 3, Coast; 4, Nepal; 5, Himalaya

rainfall, late varieties have sometimes produced the best yields. For example, Orel yielded best in 1920. Heads of White Smyrna, Hannchen, Coast, Nepal, and Himalaya barleys are shown in Figure 21.

Among the two-rowed varieties, Blackhull has been grown in all years, but has not yielded so well as several strains of White Smyrna and Hannchen. The Coast variety has averaged higher in yield than any of the other varieties grown in all years. The Orel variety

yielded well in some seasons of exceptional rainfall but not especially well in less favorable years. Horsford and Manchuria are apparently too late for best results at Akron.

The yields of the naked varieties, Nepal, Baku, and Himalaya, have been less than those of the hulled varieties. Baku has yielded nearly as well as several of the hulled varieties in some seasons, though not so well as the best hulled sorts. Nepal is not early enough to be of value, and Himalaya has been grown for too short a time to determine its worth.

The highest acre yield on fallow during the 6-year period from 1917 to 1922, inclusive, 22 bushels, was produced by Smyrna (C. I. No. 2642) (Table 27). White Smyrna (C. I. No. 195) and Coast, a six-rowed barley, produced slightly lower yields. On cornland the yields have averaged considerably lower, the highest, 16.1 bushels, being produced by White Smyrna (C. I. No. 195.) The average yields of Smyrna (C. I. No. 2642) and Coast, however, were less than a half bushel lower than that of C. I. No. 195.

TABLE 27.—*Yields of eight barley varieties grown on fallow and on cornland at the Akron Field Station, 1917–1922, inclusive*

Group and variety	C. I. No.	Acre yield (bushels)												
		Fallow							Cornland					
		1917	1918	1919	1920	1921	1922	Average	1917	1918	1919	1920	1921	1922	Average
2-rowed hulled:															
Blackhull	878	21.2	14.7	18.4	15.0	14.8	31.8	19.3	18.6	7.3	7.4	14.0	17.7	22.4	14.6
Orel	351	16.2	6.8	14.5	38.8	13.8	17.3	17.9	13.5	8.3	4.9	36.2	16.0	11.5	15.1
Smyrna	2642	20.1	18.5	13.0	29.3	18.6	32.3	22.0	14.0	8.9	7.5	26.7	17.8	20.1	15.8
White Smyrna	195	23.9	15.3	15.4	23.2	18.6	27.8	20.7	15.2	9.1	6.6	29.1	16.8	19.5	16.1
2-rowed naked:															
Baku [1]	709	11.8	7.5	12.3	19.3	15.1	14.8	13.5	6.5	4.2	4.8	18.6	15.1	8.9	9.7
6-rowed hulled:															
Coast	690	18.6	8.7	9.3	32.3	21.9	29.9	20.1	16.9	7.5	10.9	23.7	19.7	15.6	15.7
Horsford	877	11.8	4.7	8.5	18.7	16.4	20.3	13.4	10.2	5.8	4.7	15.3	17.2	12.5	11.0
6-rowed naked:															
Nepal [1]	595	9.1	3.1	9.7	16.7	17.0	15.6	11.9	5.3	2.9	4.7	22.8	9.6	10.4	9.3

[1] Yields computed at 48 pounds per bushel.

The average agronomic data recorded on the eight varieties of barley grown on fallow and on cornland (Table 28) show that the Horsford, Nepal, and Orel varieties head and ripen later than the Coast, Blackhull, Baku, and White Smyrna. The White Smyrna strains are shorter than the other varieties, but exceed some of them in total yield of straw. The varieties headed and matured at about the same time on fallow as on cornland but averaged 2 to 3 inches taller. The bushel weight of most varieties was nearly the same in the crops grown on the two soil treatments; but the naked varieties showed a much heavier bushel weight on fallow, and the reverse was true of Coast. Yields of grain and of straw averaged considerably higher on fallow.

TABLE 28.—*Average agronomic data recorded on eight varieties of barley grown on fallow and on cornland at the Akron Field Station, 1917–1922, inclusive*

Group and variety	C. I. No.	Dates of—		Height	Bushel weight	Acre yield	
		Heading	Maturity			Grain	Straw
GROWN ON FALLOW							
				Inches	*Pounds*	*Bushels*	*Pounds*
2-rowed hulled:							
Blackhull	878	June 15	July 12	25	45	19.3	1,338
Orel	351	June 27	July 21	25	45	17.9	1,534
Smyrna	2642	June 23	July 14	23	43	22.0	1,388
White Smyrna	195	June 24	...do...	22	44	20.7	1,321
2-rowed naked:							
Baku [1]	709	June 23	...do...	23	54	13.5	1,587
6-rowed hulled:							
Coast	690	June 22	July 15	27	34	20.1	1,422
Horsford	877	June 25	July 17	29	37	13.4	1,147
6-rowed naked:							
Nepal [1]	595	June 26	July 19	25	57	11.9	1,422
GROWN ON CORNLAND							
2-rowed hulled:							
Blackhull	878	June 18	July 12	22	44	14.6	1,012
Orel	351	June 28	July 21	23	45	15.1	1,145
Smyrna	2642	June 24	July 14	20	43	15.8	908
White Smyrna	195	June 23	...do...	20	43	16.0	997
2-rowed naked:							
Baku [1]	709	June 24	...do...	20	50	9.7	972
6-rowed hulled:							
Coast	690	June 23	July 15	24	37	15.7	851
Horsford	877	June 25	July 17	26	38	10.9	828
6-rowed naked:							
Nepal [1]	595	June 27	July 19	22	54	9.3	968

[1] Yields computed at 48 pounds per bushel.

NURSERY EXPERIMENTS

The nursery experiments with barley have consisted of tests of varieties and of pure-line selections. Several hundred selections have been grown in the nursery. A few promising strains have been isolated and have been grown in plats, and a number of other good selections have been increased in the nursery until sufficient seed is now available for sowing in plats.

EXPERIMENTS WITH MINOR CROPS

The crops of minor importance which have been included in experiments at Akron are rye, emmer, spelt, proso, flax, buckwheat, and grain sorghum. The experiments with these crops, with the exception of proso and grain sorghum, have not been extensive. The work with grain sorghum at present exceeds that with all the other crops named in this paragraph.

WINTER RYE

Winter rye is considered much more valuable in this district than spring rye, emmer, or spelt. Winter rye was first grown at the station in 1914. Giant Winter (C. I. No. 30) was the only variety grown until 1920, when Rosen rye was introduced. Good yields of rye were obtained in 1914, 1915, 1916, 1917, and 1922. Fair yields were obtained in 1920 and 1921 and a poor yield in 1918. The yields of rye on fallow and on cornland are compared with the yields of other cereals in Table 33, and also graphically in Figure 29.

Rye has yielded less than winter wheat but more than spring wheat. However, it is hardier and more certain than winter wheat, especially on the more sandy soils of this section, and can be sown later. The real place for rye in the district in which the station is located is apparently as a pasture and hay crop. As a pasture crop it now holds first place among sown crops. Table 29 shows the yields of the varieties of rye grown from 1914 to 1922, inclusive.

TABLE 29.—*Yields of winter and of spring rye and emmer grown at the Akron Field Station during all or part of the 15-year period, 1908–1922, inclusive* [1]

Crop and variety	C. I. No.	Acre yield (bushels)													Average		
		1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1920	1921	1922	1908 to 1922 [2]	1914 to 1922 [2]	1920 to 1922
Winter rye:																		
Giant Winter	30	----	----	----	----	----	----	25.0	27.2	21.4	17.9	5.7	13.1	15.4	16.1	------	17.7	14.9
Rosen	-----	----	----	----	----	----	----	----	----	----	----	----	[3] 28.6	13.0	17.1	------	------	19.6
Spring rye: ("Vance")	-----	----	----	----	----	----	----	----	----	----	----	----	12.0	7.5	[3] 21.6	------	------	13.7
Winter emmer:																		
Black Winter	2337	27.5	----	17.3	24.5	18.3	14.0	12.5	0	----	----	----	------	----	------	------	------	----
Buffum Improved	3331	----	----	----	----	----	19.4	9.3	----	----	----	----	------	----	------	------	------	----
Spring emmer:																		
Vernal (White Spring)	1524	26.2	37.7	31.0	20.3	38.1	15.9	20.6	70.0	13.6	14.2	4.6	42.5	6.3	9.1	25.0	22.6	19.3
Khapli	4013	----	----	----	----	----	----	----	----	16.8	----	----	------	7.1	14.6	------	------	----

[1] Grown mostly on fallow previous to 1917; in 1917 and succeeding years duplicate plats were grown on fallow and on cornland. No rye or emmer was sown in the fall of 1918. Yields of rye computed at 56 pounds to the bushel and of emmer at 32 pounds.

[2] 1919 excepted.

[3] One plat grown on fallow, none on cornland.

SPRING RYE

Only one variety of spring rye has been grown at Akron. Seed was obtained in 1920 from a farmer in the vicinity of the station and the variety has been called "Vance," after him, as the varietal name was unknown. The variety has not yielded so well as winter rye or spring wheat and has little to recommend it as a grain crop in this district. As a pasture crop it might prove of value for seeding where winter rye has failed. The yields obtained are shown in Table 29.

WINTER EMMER

Winter emmer has been grown in both plat and nursery experiments. Black Winter (C. I. No. 2337) was grown in plats in 1908, 1910, 1911, 1912, 1913, and 1914. Buffum Improved Black Winter (C. I. No. 3331), very similar to Black Winter emmer, was grown in plats in 1913 and 1914. Winter emmer has produced very low yields, as it lacked hardiness, and since 1914 has not been grown in the experiments. Owing to its lack of winter hardiness and its low market and feeding value, winter emmer has nothing to recommend it for extensive growing in this district.

SPRING EMMER

One variety of spring emmer, Vernal (White Spring; C. I. No. 1524), has been grown each year since 1908. A second variety of spring emmer, Khapli (C. I. No. 4013), was grown in 1916, 1921, and 1922. The highest yield obtained from Vernal was 70 bushels in 1915. Khapli is earlier in maturing than Vernal, possibly escapes drought better, and under severe conditions sometimes yields a little more. Emmer is often seriously injured by drought, and under the conditions at Akron it yields much less than the better varieties of barley and oats. Annual and average yields of both winter and spring varieties of emmer are shown in Table 29.

SPELT

Two varieties of spelt were sown in the nursery in the spring of 1920. These were Alstroum and Servian (C. I. No. 1724). Weather conditions were exceptionally favorable, but the spelt grew so poorly that no yield data were obtained. Spelt appears to be inferior to emmer at Akron.

PROSO

Proso,[10] commonly called hog millet or broomcorn millet, and sometimes known as hershey, has been given a comparatively thorough test. Considerable time and space have been devoted to the growing of the crop, both in plats and nursery rows, but no continuous plat experiments have been conducted. Plat experiments were sown in 1909 and from 1912 to 1922, inclusive. Good yields were obtained from the better varieties in 1914, 1915, 1917, and 1918; fair crops were harvested in 1909, 1912, 1916, and 1922; but in 1913, 1919, and 1920 the crop failed to compete successfully with the weeds and was plowed under.

The best adapted varieties under the conditions in the vicinity of Akron apparently are Black Voronezh (C. I. No. 16), Red Turghai (C. I. No. 31), and Tambov (C. I. No. 13). These varieties have been grown for at least five years and have produced good yields in most of the years grown. In favorable seasons excellent yields of proso are often obtained at Akron. The highest yield harvested was at the rate of 38.3 bushels to the acre from a plat of Tambov in 1915. Acre yields of 18 to 20 bushels have been common.

Proso seems to be well adapted to the district in which the station is located, but the market demand for it is so uncertain as to make inadvisable the extensive growing of the crop for seed. For hay it is inferior to the millets of the Siberian type and, except as a catch crop, proso can not be recommended.

FLAX

Flax has been sown in 9 of the 15 years during which experiments have been conducted. In 1911, 1914, and 1915 the crop failed. The highest yield recorded was 13.1 bushels per acre in 1912. The Russian variety was grown throughout an eight-year period and other varieties for shorter periods. No variety proved superior to Russian, which produced an eight-year average yield of only 4.4 bushels per acre. After 1916 seeding of flax was discontinued. Most of the seedings of flax were made late in May. Better results might possibly have been obtained had the crop been sown at an earlier date.

[10] For more complete information on this crop, see Martin, John H., Proso, or hog millet. U. S. Dept. Agr., Farmers' Bul. 1162, 15 p., 4 fig. 1920.

BUCKWHEAT

Buckwheat was sown each year for about 10 years. In 1908, 1909, 1912, and 1917 fair yields were obtained, and in 1910 and 1913 light crops were harvested, but in all of the other years in which buckwheat was sown it proved a failure. The highest yielding variety was Mountain (C. I. No. 31), which produced a yield of 1,712 pounds to the acre in 1912. Buckwheat has little promise for this district, because of the danger of injury from drought.

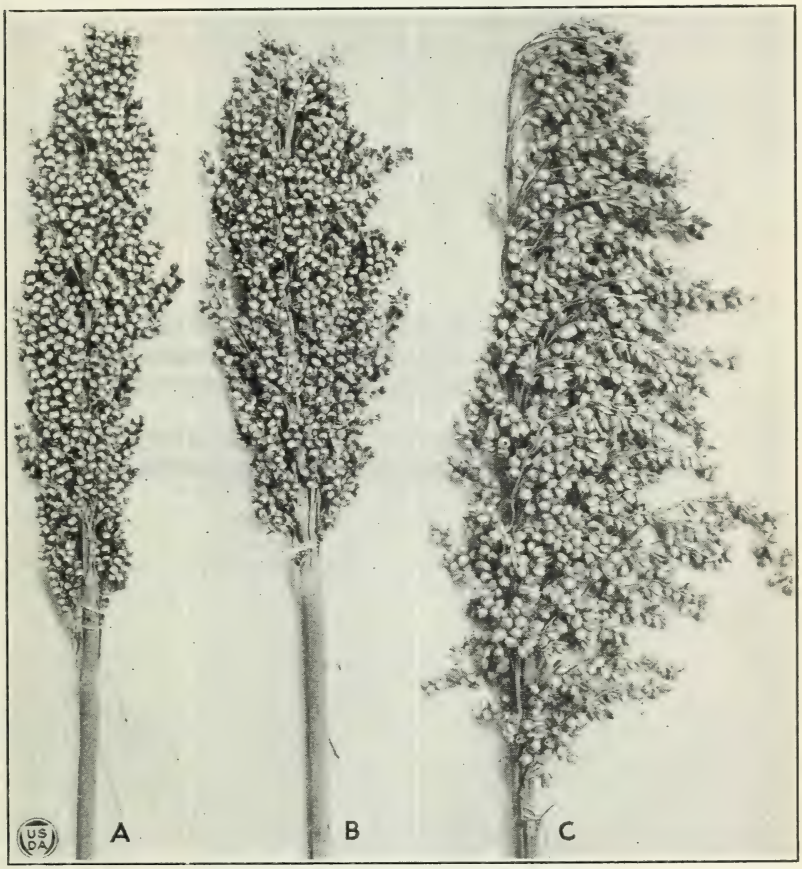

FIG. 22.—Heads of selections of Dawn kafir (A and B) and Freed sorghum (C) grown at the Akron Field Station

GRAIN SORGHUM

Grain sorghums have been grown in field plats for 12 years. On account of the short growing season and cool nights, most varieties of grain sorghums fail. Manchu Brown kaoliang (C. I. No. 328), is the only variety which has consistently escaped frost. The highest yield from this variety was 24.1 bushels in 1916; the lowest, 3.4 bushels, was produced in 1919 when the stand was reduced by a late spring frost. The twelve-year average yield has been 13.4 bushels.

Several selections have been made from Dawn kafir, some of which give promise of maturing nearly as early as the Manchu Brown kaoliang and have the advantage of shorter, stronger, and leafier stalks and white kernels. Figure 22 shows heads of Dawn kafir and Freed sorghum selections grown at Akron.

Because some of the sorgos (saccharine sorghums) produce nearly as much seed as kaoliang and kafir and at the same time yield more forage, no grain sorghums can now be generally recommended to farmers of the district. Farther south and east, milo, kafir, and feterita are well adapted.

EXPERIMENTS WITH CORN

Experiments with corn have been conducted during the past 10 years. The earlier results have been reported.[11] Detailed data are available for only three years, 1920 to 1922, inclusive. The writer, working independently, started corn-improvement studies at Akron in 1918. In 1920, 1921, and 1922 the improvement experiments were conducted as a cooperative project with the Office of Dry-Land Agri-

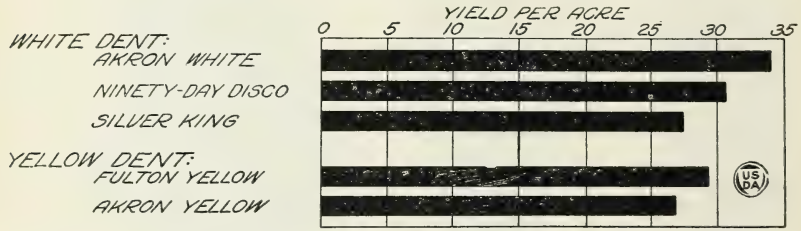

FIG. 23.—Average acre yields of five varieties of corn grown at the Akron Field Station in 1921 and 1922

culture Investigations. The corn varietal experiments, however, have been conducted as a project of the Office of Cereal Investigations during the past three years.

VARIETAL EXPERIMENTS

The yields obtained in the varietal experiments with corn in 1920, 1921, and 1922 are shown in Table 30. Figure 23 presents graphically the yields of the varieties of corn grown in 1921 and 1922. In all, 15 strains have been grown in the varietal experiments during one or more of the past three years. The corn varietal plats of 1921 were located on fallow and those of 1920 and 1922 on soil which had been cropped the previous season. The data presented in Table 30 show Fulton Yellow and Swadley to be the best yielding varieties grown for three years. Akron White has produced excellent yields during the two years it has been included in the varietal experiment. Fulton Yellow, which is a new variety in this section, appears to be among the best of the yellow strains.

The yields obtained in these experiments have been higher than may reasonably be expected under field conditions in this district, owing to the favorable corn years of 1920 and 1922 and the fact that the corn plats were planted on fallow in 1921. Corn not planted on fallow in 1921 at Akron yielded very poorly.

[11] Zook, L. L. Tests of corn varieties on the Great Plains. U. S. Dept. Agr. Bul. 307, p. 16, 17. 1915.

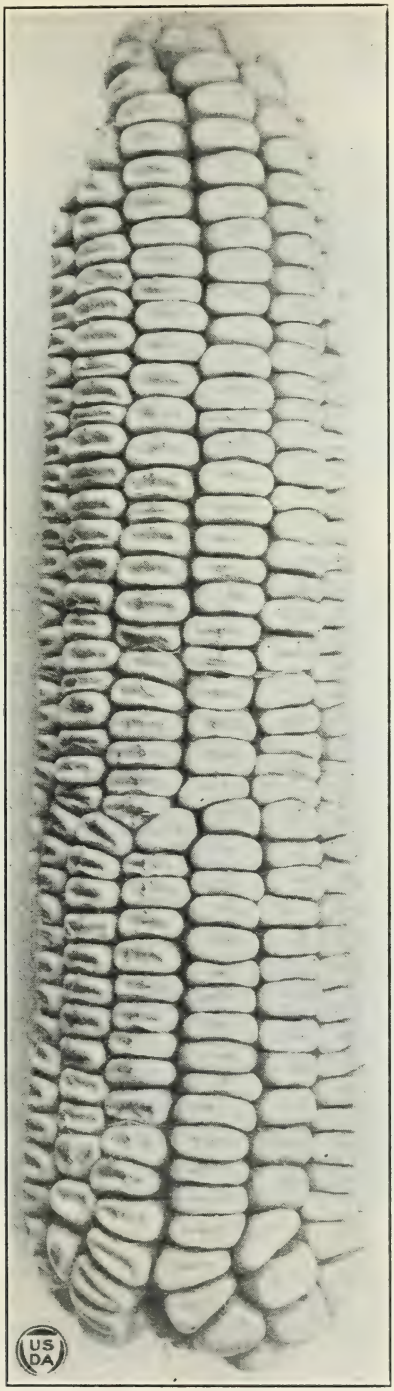

FIG. 24.—Ear of Akron White corn, a selection from Swadley developed at the Akron Field Station. (Natural size)

Akron White, which is a selection developed from Swadley, a white-capped yellowish variety, has yielded best among the white varieties, while Fulton Yellow has given the best yields among the yellow varieties. Minnesota No. 13 is considered one of the best

FIG. 25.—View of the corn-breeding plat at the Akron Field Station in 1922

varieties grown commercially in the section surrounding Akron, although it did not produce a large yield compared with Akron White in the one year it was included in the varietal experiment. A representative ear of Akron White grown at Akron is shown in Figure 24. White Cap, a white-capped red variety, similar to Colby

FIG. 26.—Corn near the Akron Field Station planted in rows 3½ feet apart. Contrast with Figure 27

Bloody Butcher, produced a very good yield in 1922 and is popular with many farmers in the section.

Figure 25 shows the corn-breeding plat in 1922. Methods of planting corn used in northeastern Colorado are illustrated in Figures 26 and 27.

TABLE 30.—*Yields of corn varieties grown at the Akron Field Station in one or more of the three years, 1920, 1921, and 1922*

Class and variety	Acre yield (bushels)				
	1920	1921	1922	Average	
				1920 to 1922	1921 and 1922
White dent:					
Akron White		37.0	31.0		34.0
Silver King	36.2	29.4	25.2	30.3	27.3
Swadley	55.0	37.0	[1] 10.7	34.2	23.9
Ninety-Day Disco		38.6	22.5		30.6
Yellow dent:					
Akron Yellow	35.7	28.1	25.0	29.6	26.6
Fulton Yellow	46.3	33.3	25.2	34.9	29.3
Reg. Minn. No. 13			12.2		
Minn. No. 13			24.0		
U. S. Selection 125		21.6	16.2		18.9
U. S. Selection 182	16.2				
U. S. Selection 193	35.9				
U. S. Selection 202	38.2				
Miscellaneous:					
White Cap			27.0		
Northwestern Dent			15.0		
Pearl Flint	27.1				

[1] Very poor stand, owing to destruction of the seed by ground squirrels.

FIG. 27.—Corn near the Akron Field Station planted in rows 7 feet apart. Contrast with Figure 26

CORN IMPROVEMENT

Corn-improvement studies have been in progress for five years. The writer conducted the experiments independently in 1918 and 1919. In 1920, 1921, and 1922 corn-improvement work was conducted as a cooperative project between the Offices of Cereal Investigations and Dry-Land Agriculture Investigations. Starting in 1922 a definite project was formulated by the Office of Cereal Investigations for the improvement of corn at Akron, which will be continued in the future. Several promising selections of Swadley were made by the ear-row method in 1918, 1919, and 1920. The most promising of these strains is Akron White, selected in 1917, which has outyielded the parent variety by an average of over 10 bushels per acre during the past five years. Two or three promising selections were made in 1919 and several more in 1920 and 1921.

In 1921 and 1922, selection of several additional varieties was started and some promising strains have been isolated. Selfing and cross-fertilization experiments were started in 1921, and this work was in-

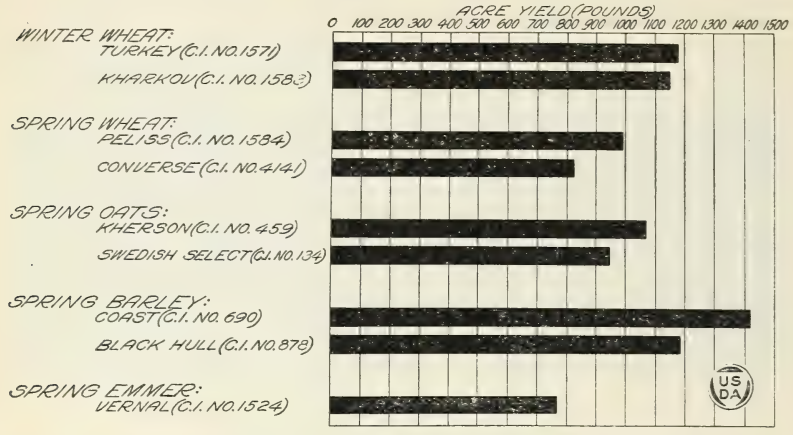
ACRE YIELD (POUNDS)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
WINTER WHEAT:
TURKEY (C.I. NO. 1571)
KHARKOV (C.I. NO. 1583)
SPRING WHEAT:
PELISS (C.I. NO. 1584)
CONVERSE (C.I. NO. 4141)
SPRING OATS:
KHERSON (C.I. NO. 459)
SWEDISH SELECT (C.I. NO. 134)
SPRING BARLEY:
COAST (C.I. NO. 690)
BLACK HULL (C.I. NO. 878)
SPRING EMMER:
VERNAL (C.I. NO. 1524)
USDA

FIG. 28.—Average acre yields of the leading cereal varieties at the Akron Field Station during the 15-year period, 1908–1922, inclusive

creased in 1922. More corn breeding of this nature is being planned. Many corn problems are unsolved in the dry-land areas, and more scientific experiments for their solution are planned. Table 31 shows

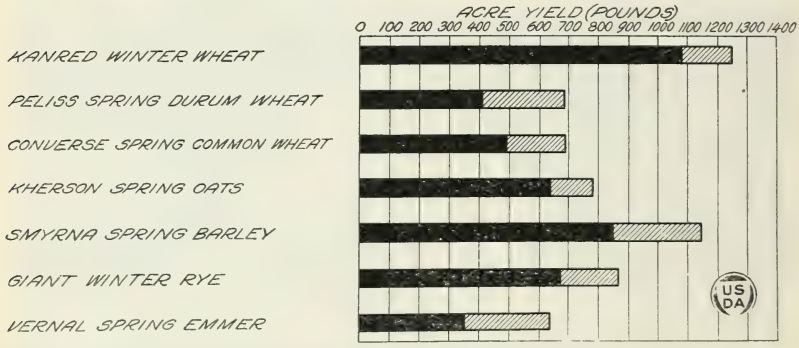
ACRE YIELD (POUNDS)
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400
KANRED WINTER WHEAT
PELISS SPRING DURUM WHEAT
CONVERSE SPRING COMMON WHEAT
KHERSON SPRING OATS
SMYRNA SPRING BARLEY
GIANT WINTER RYE
VERNAL SPRING EMMER
USDA

FIG. 29.—Average acre yields of the leading cereal varieties when grown at the Akron Field Station on corn-land and on fallow in the five years, 1917, 1918, 1920, 1921, and 1922

the annual and average yields of Akron White and the parental variety, Swadley, during the 5-year period, 1918–1922, inclusive.

TABLE 31.—*Yields of Akron White and Swadley corn grown at the Akron Field Station, 1918–1922, inclusive*

Variety	Acre yield (bushels)					
	1918	1919	1920	1921	1922	Average
Akron White	58.9	5.7	36.1	37.0	31.0	33.7
Swadley	30.2	6.4	27.0	37.0	[1] 10.7	22.3

[1] Very poor stand, owing to injury by ground squirrels.

COMPARISON OF GRAIN CROPS

Comparisons of the acre yields, in pounds, of all cereals at Akron are shown in Tables 32 and 33, and graphically in Figures 28 and 29. The yields of the most important varieties of each cereal studied for the 15-year period from 1908 to 1922, inclusive, are shown in Table 32. In Table 33 the yields of the better varieties of each cereal on fallow and on cornland during the 6-year period from 1917 to 1922, inclusive, are presented. The varieties used in these two comparisons differ somewhat. All of the small grains were grown under comparable conditions nearly every year, but the varieties of corn, grain sorghum, and proso were not grown under conditions which were comparable with the small grains. Usually all the small grains were grown on the same part of the station in any one year, and the preparation of the soil and date of sowing were approximately the same for all the spring varieties.

TABLE 32.—*Yields of the leading varieties of cereals grown at the Akron Field Station, 1908–1922, inclusive*

Crop and variety	C. I. No.	Acre yield (pounds)														
		1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	Average
Winter wheat:																	
Turkey	1571	1,188	0	1,770	702	2,586	438	1,506	1,686	1,902	510	1,104	[1]	1,302	918	762	[2]1,170
Kharkof	1583	1,158	0	1,788	852	2,250	996	1,560	1,752	1,572	1,014	738	[3]1,056	966	780	852	1,156
Spring wheat:																	
Peliss	1584	1,482	1,416	948	636	2,136	630	1,596	1,896	864	468	222	528	1,014	546	474	990
Converse	4141	[4]888	912	936	726	1,392	498	1,380	1,434	462	420	450	666	1,008	402	648	815
Spring oats:																	
Kherson	459	1,690	1,059	1,107	397	1,232	1,155	2,141	2,720	538	470	195	358	1,254	790	822	1,062
Swedish Select	134	2,000	1,622	941	714	966	880	1,558	2,221	336	294	86	138	1,533	509	304	940
Spring barley:																	
Coast	690	1,853	1,574	1,229	802	1,848	1,080	2,846	3,797	998	854	389	490	1,344	998	1,090	1,413
Blackhull	878	1,219	965	1,142	278	1,277	1,219	2,059	3,701	946	955	528	619	696	778	1,301	1,179
Spring emmer:																	
Vernal	1524	838	1,206	992	650	1,219	509	659	2,240	435	454	147	317	1,360	202	291	768

[1] No winter-wheat varietal plats sown in fall of 1918.
[2] 1919 not included.
[3] Yield of increase field.
[4] Average yield of similar varieties, Erivan and Fretes.

No winter wheat was sown in the varietal experiments in the fall of 1918. The only winter wheat yields available for 1919 are those of increase fields of Kharkof and Kanred. Including this yield, the average production of Kharkof wheat in the 15-year period was 1,156 pounds, as compared with 990 pounds of Peliss durum wheat and 815 pounds of Converse, a hard red spring wheat. Excluding 1919 yields, Turkey winter wheat has averaged 1,170 pounds, Kharkof 1,163 pounds, Peliss 1,023 pounds, and Converse 825 pounds.

Kherson oat, an early variety, has averaged 1,062 pounds annually during the 15 years, as compared with 940 pounds for Swedish Select, a midseason oat. The Kherson oat has produced a greater total yield than any spring wheat, but less than the best winter wheats.

Coast barley has produced an average yield of 1,413 pounds in the 15-year period, as compared with 1,179 pounds for Blackhull barley. When compared with oats, Coast barley has produced on

the average 351 pounds and Blackhull barley 117 pounds per acre annually more than Kherson, the best-yielding oat variety, thus clearly establishing the superiority in yield of the best barleys over the best oats in the 15-year period.

The one variety of spring emmer has yielded less than either oats or barley. The 15-year average yield has been 768 pounds, or 172 pounds less than the yields of the midseason oat variety, Swedish Select.

The yields on fallow and on cornland (Table 33) show clearly that the yields on fallow have not been sufficiently increased in any case to compensate for the loss of the alternate crop. Corn grown in alternation with the small grains averaged about 20 bushels to the acre during the six years. This is equal to approximately 1,100 pounds, which is slightly higher than can be normally expected as a yield of corn in this section on land prepared in the usual way.

TABLE 33.—*Yields of the leading varieties of grain crops grown on fallow and on cornland at the Akron Field Station, 1917–1922, inclusive*[1]

Crop and variety	C. I. No.	Acre yield (pounds)							
		1917	1918	1919	1920	1921	1922	Average	
								1917 to 1922	1917,1918, 1920 to 1922
Grown on fallow:									
Kanred winter wheat	5146	888	1,356	(2)	1,674	1,116	1,170	----	1,241
Peliss (durum) spring wheat	1584	726	252	588	1,236	606	582	665	680
Converse spring wheat	4141	618	480	810	1,110	498	708	704	683
Kherson spring oats	459	525	237	544	1,251	970	947	746	786
Smyrna spring barley	2642	965	888	624	1,406	893	1,550	1,054	1,140
Giant Winter rye	30	1,036	330	(2)	734	924	1,271	----	859
Vernal spring emmer	1524	600	175	[3] 317	1,688	210	458	575	626
Akron White corn [4]	----	----	3,298	319	2,017	2,072	1,680	----	----
Brown Manchu grain sorghum	328	603	1,038	197	789	418	----	----	----
Red Turghai proso	31	1,776	1,260	0	0	738	1,314	848	1,018
Grown on cornland:									
Kanred winter wheat	5146	1,224	1,050	(2)	[5] 1,938	594	576	----	1,076
Peliss (durum) spring wheat	1584	210	192	456	792	480	360	415	407
Converse spring wheat	4141	228	426	522	912	306	582	496	491
Kherson spring oats	459	413	157	173	1,258	614	701	553	629
Smyrna spring barley	2642	672	427	360	1,282	854	965	760	840
Giant Winter rye	30	969	302	(2)	734	806	526	----	667
Vernal spring emmer	1524	306	118	[3] 317	1,031	172	125	345	350

[1] Corn, grain sorghum, and proso were usually, though not always, grown on fallow.
[2] No winter-grain plats were sown in the fall of 1918 at Akron.
[3] Average on both fallow and cornland.
[4] Pounds of shelled corn.
[5] Yield increased by surface drainage of storm water from other plats. Yields probably higher than can be expected over a long period.

Winter wheat grown on fallow produced an average yield of 1,241 pounds as compared with 1,076 pounds on cornland, a difference of only 165 pounds. On the average, the yields on the two soil preparations probably will be more nearly in the ratio of 3 pounds on fallow to 2 on cornland. The plats of Kanred on cornland were in an especially favored location one season, and in so short a period this is not equalized.

Both durum and hard red spring wheats have produced so poorly on cornland that they can not be recommended; they yielded less than half those of winter wheat for the same years. On fallow, spring wheat yielded better, but can be recommended only for the reseeding of fields where winter wheat has failed.

The average yield of oats on both fallow and cornland during the 6-year period was low, and the seeding of even the best varieties in this section is justly very limited. Acre yields in pounds are slightly in excess of yields of spring wheat. Barley has produced fair yields on fallow as well as on cornland, averaging 1,054 and 760 pounds, respectively. The superiority of barley over the best oat varieties for feed production is clearly demonstrated. Both oats and barley are better than spring emmer, which has yielded only 575 pounds on fallow and 345 pounds on cornland.

Winter rye appears to be a better cash grain crop than any of the other cereals except winter wheat. The price of rye is usually high enough so that the crop brings a greater return than spring durum wheat or barley.

Winter rye possibly has a more important place in the cropping systems on the more sandy soils, which are likely to blow, than on the "hard lands." It is not so easily damaged by blowing as is winter wheat and yields better than any of the other small grains. At the station the yields of winter rye are 300 to 400 pounds less than those of the best winter wheats.

The yields of corn possibly are higher than can normally be expected. About 800 to 1,000 pounds of shelled corn to the acre would be more nearly a normal yield on average soil, cropped the previous season. The data clearly indicate, however, that corn has a very definite place in the district, as it is one of the most productive crops that can be grown. Corn works well into a rotation and makes a fair quantity of roughage for livestock, as well as a yield of about 15 bushels of grain to the acre on soil previously cropped,

The yields of grain sorghum have been less than those of any other cereal except emmer. Unless a better yielding strain than Manchu Brown kaoliang can be developed, grain sorghum has little place in the cropping system of the district around Akron. Proso has yielded well in the seasons when any crop was produced and with the exception of corn and barley has outyielded all other feed grain crops. However, it is usually necessary to grind the seed before feeding, and there often is little or no market demand for the seed. These facts and the danger of total failure in unfavorable years make the crop of doubtful value.

CHOICE OF CROPS AND TYPES OF FARMING RECOMMENDED

The value of corn in this district is only partly recognized. Most of the crop is now husked from the standing stalks and the fields are then pastured by livestock. A few fields are cut with corn binders and the fodder is fed to the livestock after the ears have been removed. As yet there are few silos of any kind in the district, although the climate and soil are very favorable to the use of the pit silo, which can be built at a comparatively small cost.

Most of the district in which the station is located is too dry to grow alfalfa successfully, and sweet clover generally has given only fair results, owing to the difficulty of obtaining stands. No legume suitable for hay purposes is now grown generally. The sorghums, Sudan grass, winter rye, and millet are used for roughage, the concentrates commonly fed being ear corn and threshed barley. Larger profits from the feeding of livestock, particularly dairy cows, probably

would result if the roughage were supplemented with corn or sorgo silage. Grinding the barley and shelling the corn before feeding are advisable.

The need for diversified farming in this district is urgent. The one-crop system can not prove successful where the farmer must contend with so many risks. Although grain production is likely to remain the leading industry, the growing of winter wheat to the exclusion of all the other cereals is a questionable practice. Few sections in the United States which follow wheat farming alone are permanently prosperous. Certain individuals may escape the failures and accumulate considerable property, but the average person who follows exclusive wheat farming has not found himself greatly enriched by it in the long run.

In the district surrounding the Akron Field Station winter wheat is the cash crop of prime importance. Spring wheat may serve as a catch crop in years when winter wheat fails to survive. Barley is a very valuable grain feed crop, especially when ground. Corn is also an important feed crop which with careful attention generally yields about the same as barley. It has the added advantage, however, of making excellent silage. The sorgos are excellent forage crops in this section and often yield from 2 to 3 tons to the acre. They are also suitable for silage. Rye is a very good late-fall and early-spring pasture crop when sown early in the fall. When cut just before maturity it makes reasonably good hay. It is also a good cash crop in the more sandy sections where the growing of winter wheat is not advisable. Oats when sown early in the spring usually make a fair yield of grain. In seasons of severe drought the oats can be mowed and will make excellent hay. Proso and millet are of doubtful value for seed crops, but millet often makes an excellent yield of forage of good quality. There is great need for a legume which will consistently produce good yields of forage and pasturage under dry-land conditions.

The farmer of this section has a considerable range of crops from which to select and few years will occur when all of them produce poor yields. The experience of the most successful farmers has shown that a system of farming which includes the growing of a considerable acreage of winter wheat as a cash crop, possibly an equal acreage of the other cereals, and sufficient forage for the feeding of work stock and a few good dairy cows is the most profitable type to recommend for this part of the Great Plains. Grain production should be combined with livestock farming, especially dairying and the raising of poultry and a few hogs.

SUMMARY

Experiments with cereals have been conducted on dry land at the Akron field station, Akron, Colo., during the 15 years from 1908 to 1922, inclusive.

The station is located in northeastern Colorado, about 60 miles from the Nebraska line on the east and on the north. The results obtained there are generally applicable to eastern Colorado, northwestern Kansas, western Nebraska, and southeastern Wyoming.

The section is primarily devoted to grain production. The most important grain crops are winter wheat, corn, spring wheat, barley,

rye, and oats. Possibly 7,000,000 acres in this section are cropped. As only about one-third of the area is under cultivation, considerable room for agricultural expansion remains.

The soil on which the experiments were conducted is a sandy loam.

The average annual precipitation for 15 years is 17.93 inches, of which 13.68 inches fell during the growing season, April 1 to September 30. The annual precipitation has ranged from 25 inches in 1915 to 13.44 inches in 1921. The seasonal precipitation is a very important factor and greatly influences grain yields.

The average yields of the better adapted varieties of wheat, corn, barley, rye, oats, and sorghum have been fairly satisfactory, but partial or complete failures in some years of several crops make single-crop farming uncertain. Other small grains yield less than winter wheat.

Crimean winter wheats have produced higher yields than durum or hard red spring wheats. Kanred is the highest yielding variety now being grown. Turkey winter wheat has produced good yields over a long period of years. Peliss durum has outyielded all other spring wheats. Winter wheat should be sown as early in the fall as climatic conditions and soil moisture justify. Too early seeding probably will not prove to be good practice, as the crop may dry out later. Spring wheat should be sown as early in the spring as soil conditions permit. The seeding rates from which the best results have been produced are from 3 to 5 pecks per acre for both winter and spring wheat varieties.

Fallowing for either winter or spring wheat is probably not justified, as the yields usually are not sufficiently increased over those on land in corn or other cultivated crops to justify the expense. Rotating corn and wheat is apparently the most satisfactory practice.

The seeding of spring wheat can not be recommended, except possibly as a catch crop where a feed crop is not desired. Winter wheat, although sown as late as the middle of October, usually will outyield spring wheat.

The early varieties of oats—Kherson, Albion, and Colburt—have produced the highest yields. These varieties should be sown at the rate of at least 4 pecks per acre, as early in the spring as soil and weather conditions permit. Oats yield less than barley in the vicinity of Akron. They are more popular in the northern and western parts of the district.

The early varieties of barley, Coast and White Smyrna, have produced the highest yields. Barley should be sown as early as possible at the rate of at least 4 pecks per acre. Although not so popular as corn, spring barley is a most valuable feed crop in the section.

Winter rye has produced nearly as high yields as winter wheat in several seasons. It is slightly more certain than winter wheat; but yields less and sells for a smaller price per bushel. In the more sandy sections it is a valuable grain crop. It is apparently most useful in this district as a pasture crop. Spring rye, spring emmer, and spelt are of little value in the section. None of these crops yields so well as the best varieties of barley or oats. Winter emmer is not winter hardy enough to be grown successfully in northeastern Colorado.

The seeding of proso, or hershey, has not been generally profitable, owing to the uncertainty of market demand. Red Turghai, Red Russian, and Black Voronezh are the most valuable varieties in the section. Proso may be sown with an ordinary grain drill at the rate of 15 to 20 pounds per acre.

The general seeding of flax and buckwheat is not believed advisable, as neither appears to be sufficiently adapted to justify growing it. Possibly better results could be obtained by sowing flax at an earlier date than has been practiced in the Akron experiments.

Most of the grain sorghums mature too late and require too much warm weather to be successfully grown at Akron. Manchu Brown kaoliang is the most certain of the varieties which have been grown for any length of time. Several selections from Dawn kafir have been developed at the Akron Field Station which give considerable promise for the district.

During the past five years considerable work has been done in selecting corn. The most valuable variety at Akron is apparently Akron White dent, a selection from Swadley made at the Akron Field Station.

The following varieties appear to be best adapted and are therefore recommended for growing in this district:

Winter wheat	Kanred, Turkey.
Spring wheat	Peliss, Arnautka, Akrona, Converse (Red Russian).
Spring barley	Coast, Smyrna.
Spring oats	Kherson, Albion, Colburt.
Proso	Red Turghai.
Grain sorghum	Manchu Brown kaoliang, Dawn kafir selections.
Corn	Akron White, Fulton Yellow, Minnesota No. 13, White Cap.